

Proposal # 2001- <u>F-210</u> (Office Use Only)
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PSP Cover Sheet

Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic
 Proposal Title: Pesticides and Heavy Metals in Invertebrates and Fish in the Sac.-San J. Delta
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Amount of funding requested: \$ _____

Some entities charge different costs dependent on the source of the funds. If it is different for state or federal funds list below.

State cost \$ 863,253

Federal cost \$ 1,140,834

Cost share partners? _____ Yes _____ X No

Identify partners and amount contributed by each _____

Indicate the Topic for which you are applying (check only one box).

- | | |
|--|--|
| <input type="checkbox"/> Natural Flow Regimes | <input type="checkbox"/> Beyond the Riparian Corridor |
| <input checked="" type="checkbox"/> Nonnative Invasive Species | <input type="checkbox"/> Local Watershed Stewardship |
| <input type="checkbox"/> Channel Dynamics/Sediment Transport | <input type="checkbox"/> Environmental Education |
| <input type="checkbox"/> Flood Management | <input checked="" type="checkbox"/> Special Status Species Surveys and Studies |
| <input type="checkbox"/> Shallow Water Tidal/ Marsh Habitat | <input type="checkbox"/> Fishery Monitoring, Assessment and Research |
| <input checked="" type="checkbox"/> Contaminants | <input type="checkbox"/> Fish Screens |

What county or counties is the project located in? Solano, Sacramento, San Joaquin, Contra Costa

What CALFED ecozone is the project located in? See attached list and indicate number. Be as specific as possible Ecol. Management Zone 1/Delta

Indicate the type of applicant (check only one box):

- | | |
|--|---|
| <input type="checkbox"/> State agency | <input type="checkbox"/> Federal agency |
| <input type="checkbox"/> Public/Non-profit joint venture | <input type="checkbox"/> Non-profit |
| <input type="checkbox"/> Local government/district | <input type="checkbox"/> Tribes |
| <input checked="" type="checkbox"/> University | <input type="checkbox"/> Private party |
| <input type="checkbox"/> Other: _____ | |

Indicate the primary species which the proposal addresses (check all that apply):

- | | |
|--|---|
| <input type="checkbox"/> San Joaquin and East-side Delta tributaries fall-run chinook salmon | <input type="checkbox"/> Spring-run chinook salmon |
| <input type="checkbox"/> Winter-run chinook salmon | <input type="checkbox"/> Fall-run chinook salmon |
| <input type="checkbox"/> Late-fall run chinook salmon | <input type="checkbox"/> Longfin smelt |
| <input type="checkbox"/> Delta smelt | <input type="checkbox"/> Steelhead trout |
| <input type="checkbox"/> Splittail | <input type="checkbox"/> Striped bass |
| <input checked="" type="checkbox"/> Green sturgeon | <input checked="" type="checkbox"/> All chinook species |
| <input checked="" type="checkbox"/> White Sturgeon | <input type="checkbox"/> All anadromous salmonids |
| <input type="checkbox"/> Waterfowl and Shorebirds | <input type="checkbox"/> American shad |
| <input type="checkbox"/> Migratory birds | |
| <input type="checkbox"/> Other listed T/E species: _____ | |

Indicate the type of project (check only one box):

- | | |
|---|---|
| <input checked="" type="checkbox"/> Research/Monitoring | <input type="checkbox"/> Watershed Planning |
| <input type="checkbox"/> Pilot/Demo Project | <input type="checkbox"/> Education |
| <input type="checkbox"/> Full-scale Implementation | |

Is this a next-phase of an ongoing project? Yes _____ No X
Have you received funding from CALFED before? Yes _____ No X

If yes, list project title and CALFED number _____

Have you received funding from CVPIA before? Yes _____ No X

If yes, list CVPIA program providing funding, project title and CVPIA number (if applicable):

By signing below, the applicant declares the following:

- The truthfulness of all representations in their proposal;
- The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and
- The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

INGERBORG WERNER

Printed name of applicant

I. Werner

Signature of applicant

Title of Project: Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta

Amount Requested: \$ 863,252 (State Funds)
\$ 1,140,834 (Federal Funds)

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Type of Organization: State-controlled university

Tax Status: Tax-exempt

Employer Identification Number: 94-6036494W

Executive Summary

Aquatic organisms of the Sacramento-San Joaquin Delta are potentially exposed to a large variety of toxicants, whose combined effect(s) on invertebrate and vertebrate populations are largely unknown. Whereas information on the effects of dissolved compounds is relatively abundant, the effects of hydrophobic contaminants and heavy metals, in particular as mixtures, have rarely been studied. In surface waters, heavy metals and hydrophobic organic contaminants partition preferentially to sediment particles and suspended matter. Both heavy metals and hydrophobic organic compounds can be taken up and bioaccumulated from the sediments by benthic invertebrates, which potentially serve as vectors for transfer to higher trophic levels such as fish and, ultimately, humans. Mobilization of such contaminants by benthic organisms can affect higher trophic levels in two ways: 1) Direct toxic effects on benthic invertebrates leads to a depletion of food resources for organisms at higher trophic levels such as fish. 2) Dietary uptake of xenobiotic compounds results in bioaccumulation and/or toxic effects to organisms at higher trophic levels. This research project will focus on the effects of heavy metals and hydrophobic pesticides which can be accumulated by benthic organisms and have potential for food chain transfer to higher trophic levels.

The study will be conducted over a three year period and has three main components: 1) Measurement of bioaccumulation of hydrophobic pesticides and heavy metals in two (epi)-benthic invertebrate species, the introduced clam species *Corbicula fluminea* and the amphipod *Gammarus daiberi*, collected from 4 selected sites in the Delta. 2) Determination of population structure and health in *C. fluminea* and *G. daiberi* at selected sites. 3) Measurement of the effects of dietary exposure to hydrophobic pesticides and heavy metals – singly and in mixtures – in two species of fish, white sturgeon (*Acipenser transmontanus*) and chinook salmon (*Oncorhynchus tshawytscha*).

We will collect two common resident invertebrate species, *G. daiberi* and *C. fluminea*, from field stations selected based on monitoring data from the Department of Water Resources and available information on toxicity in the Delta. Chemical analyses of concentrations of hydrophobic pesticides and heavy metals will be performed on sediment and tissue samples (Task 1), and correlated with population structure and health parameters. Population structure and dynamics will be determined by measuring age distribution over a period of two years (Task 2). Population health will be measured by means of a suite of histological and cellular indicators of exposure and effect (Task 3). These include histopathology, stress proteins, lysosomal membrane integrity, available cellular energy (glycogen, ATP/ADP), and metabolic enzyme activity (ATPase, carboxylesterase, P450). In a second phase, we will carry out laboratory feeding experiments with two fish species, juvenile salmon and white sturgeon, to investigate acute and chronic effects of dietary exposure to mixtures of heavy metals and hydrophobic pesticides (Task 4). Exposure concentrations will reflect chemical concentrations measured in tissues of field collected invertebrates. Sublethal parameters measured in fish will include metabolic enzymes, histopathologic lesions, stress proteins, lysosomal membrane integrity, energy budget (glycogen, adenylate energy charge), vitellogenin/choriogenin levels and immunological endpoints such as macrophage activity or cortisol levels. These laboratory feeding studies will be strongly coordinated with ongoing Calfed funded projects (see attached letters of collaboration). Results and recommendations will be made available in a format intended for use by environmental managers (Task 5).

Project Description

Problem: Aquatic organisms of the Sacramento-San Joaquin Delta are potentially exposed to a large variety of sediment bound toxicants, whose combined effect(s) are not known. Heavy metals such as cadmium, selenium, mercury, copper, silver and lead continue to be transported into the Delta from numerous sources (Montoya and Pan 1992, Fujimura et al. 1995, Cain et al. 1998, Clark 1998), and pesticides applied in agriculture and urban areas enter the streams through aerial drift, irrigation water or storm runoff (Foe and Connor 1991, Connor et al. 1993, Foe and Sheipline 1993, Connor et al. 1994, Kuivila and Foe 1995, USGS 1997, 1998a, 1998b, Foe et al. 1998, Werner et al. 2000). High levels of DDT, and its degradates DDD and DDE continue to be detected in sediments, fish and clams of the San Joaquin River (Pereira et al. 1996), and more recently, application of hydrophobic pyrethroid pesticides is increasingly replacing organophosphate pesticides in an attempt to reduce surface runoff and transport into lakes and rivers.

Bioaccumulation of hydrophobic pesticides and heavy metals from sediments and consequent food chain transfer are important routes of contaminant exposure for benthic and epibenthic organisms and their predator species (see Fig. 1: **Conceptual Model**). Numerous heavy metals have been shown to accumulate in aquatic invertebrates (Brown and Luoma 1995, Suchanek et al. 1995, Slotton et al. 1995), and Pereira et al. (1996) measured bioaccumulation of the organophosphate pesticide chlorpyrifos and chlorinated pesticides such as DDT in the clam *Corbicula fluminea* in the San Joaquin river and its tributaries. Pyrethroid pesticides are hydrophobic ($K_{ow}=6.22$), relatively persistent (half-life of esfenvalerate = 66-287 days) and highly toxic to many aquatic species. Studies have shown that the pyrethroid esfenvalerate ('Asana') has detrimental effects on aquatic systems by reduction or elimination of many crustaceans, chironomids, juvenile bluegills and larval cyprinids at exposure levels of 1 ppb (Lozano et al. 1992, Tanner and Knuth 1996). Bivalves, on the other hand, are less susceptible and bioaccumulate these compounds (bioconcentration factor of fenvalerate in oysters: >4,700; Clark et al. 1989). The potential of food chain transfer of pyrethroids is therefore high, and fish feeding on bivalves or on other mollusc species could be at high risk of toxic effects. Long-term toxic effects of pyrethroids in humans are presently unknown, but Repetto and Baliga (1997) demonstrated suppressive effects on the immune system. Benthic organisms can be vectors for transfer of potentially toxic concentrations of these pollutants from sediments to higher trophic levels. They may also serve as early indicators for the bioavailability of sediment bound contaminants and the potential for food chain transfer. Alternatively, direct toxic effects on invertebrate populations may deplete food resources for predator species such as white sturgeon and juvenile salmon. It is therefore important to study the links between sediment-associated contaminants, bioaccumulation, toxic effects in (epi-)benthic invertebrates, and toxic effects of dietary exposure in fish feeding on such species.

Objectives: This research project will focus on the effects of heavy metals and hydrophobic pesticides – singly and in mixtures –, which can be accumulated by epi-benthic and benthic organisms and have potential for food chain transfer to higher trophic levels. It will yield new information on the effects of bioaccumulation and dietary uptake of hydrophobic pesticides (pyrethroids, organochlorines, certain organophosphates) and heavy metals on fish and invertebrates resident in the Sacramento-San Joaquin Delta. We propose an integrated field and laboratory study with the following objectives:

- ❑ Measure bioaccumulation of sediment bound heavy metals and hydrophobic pesticides such as organochlorines, chlorpyrifos and pyrethroids in two invertebrate species resident in the Sacramento-San Joaquin delta, the amphipod *Gammarus daiberi* and the clam *Corbicula fluminea*, known food resources for juvenile salmon and white sturgeon.
- ❑ Evaluate the influence of heavy metals and hydrophobic pesticides on population structure and dynamics of *G. daiberi* and *C. fluminea*.
- ❑ Measure health parameters (biomarkers) in populations of *G. daiberi* and *C. fluminea* and evaluate the influence of heavy metals and hydrophobic pesticides.
- ❑ Conduct laboratory studies to measure pollutant transfer and effects of dietary exposure to mixtures of heavy metals and hydrophobic pesticides in white sturgeon and juvenile chinook salmon.
- ❑ Integrate existing information and data developed during these studies to formulate recommendations for monitoring and management strategy of sediment bound pollutants in the Sacramento-San Joaquin Delta.

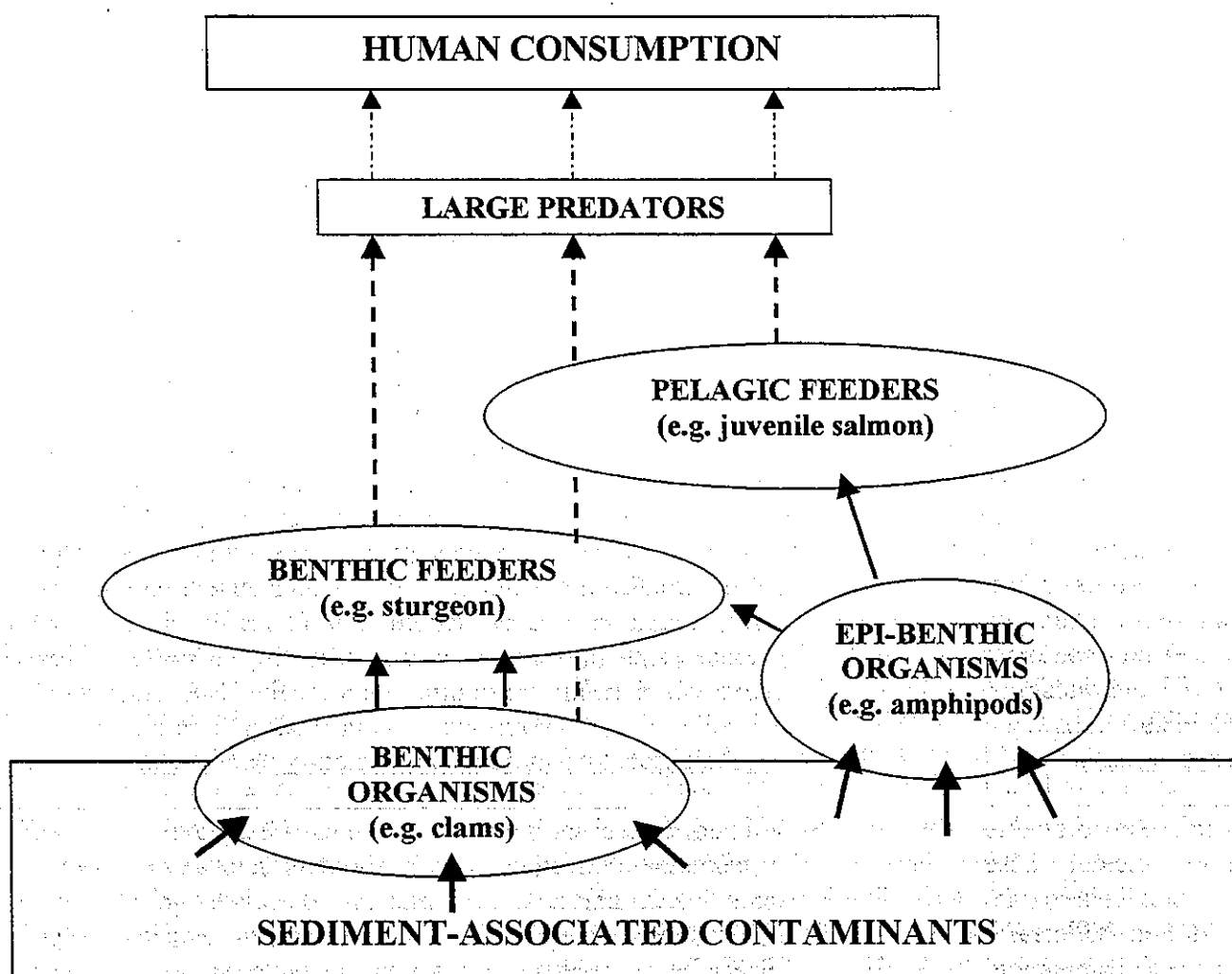


Figure 1. Conceptual model of transfer of hydrophobic organic compounds and heavy metals to benthic organisms and across trophic levels (pathways investigated in this study are indicated as solid arrows).

Hypotheses and Relationship to Adaptive Management

Task 1: Bioaccumulation and pollutant transfer of sediment bound heavy metals and hydrophobic pesticides: - The amphipod *Gammarus daiberi* and the introduced freshwater clam *Corbicula fluminea* are two of the most common and abundant members of the Delta benthic assemblage (Thompson *et al.*, 1999), and were selected for study because they are dietary components for the target fish species, white sturgeon and juvenile salmon (Bennett and Moyle 1996, Kjelson *et al.* 1982). Both species interact with the sediment throughout their life span and are likely to accumulate sediment-associated contaminants. We will test the hypothesis that sediment-associated hydrophobic pesticides are bioaccumulated by these organisms and consequently transferred to predator species such as white sturgeon and juvenile chinook salmon. Results from the field studies on invertebrate bioaccumulation will enable us to identify contaminants of concern, which will then be tested for toxic effects in our laboratory feeding studies with sturgeon and salmon (Task 4).

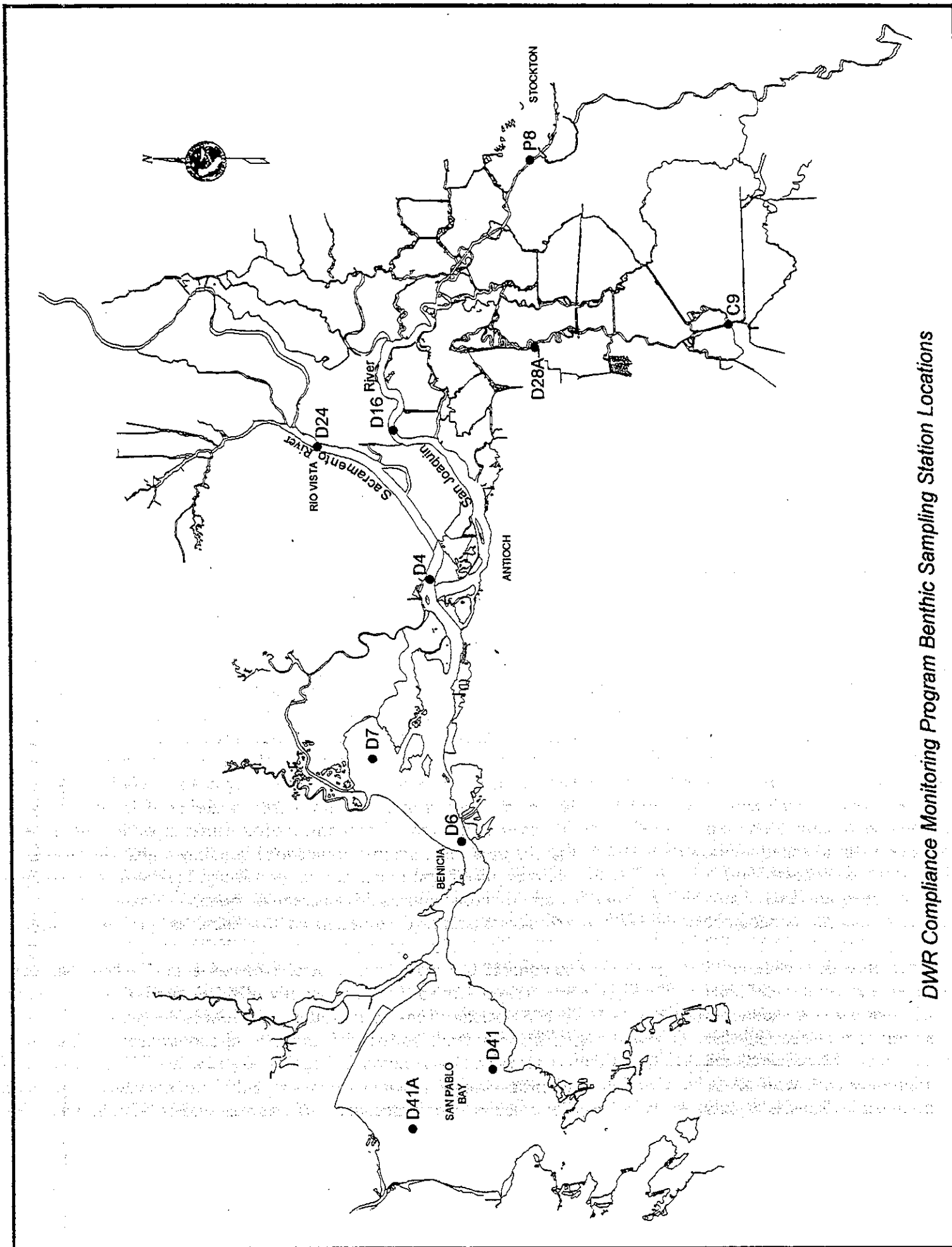
Task 2: Evaluation of the influence of heavy metals and hydrophobic pesticides on population structure and dynamics of *G. daiberi* and *C. fluminea*: Invertebrates are essential members of a healthy ecosystem, and declining trends in population levels can have serious consequences for organisms at higher trophic levels. The cause(s) of decline is (are) often difficult to determine because population responses integrate several key population processes such as recruitment, growth, reproduction, and mortality rates and numerous factors can influence populations. The proposed study will address the hypothesis that there is no difference in recruitment, growth, and mortality rates in the clam *C. fluminea* and the amphipod *G. daiberi* at locations with relatively uncontaminated and contaminated sediments. Contaminants may potentially impact any population response parameter. Comparisons of those rates between contaminated and uncontaminated locations may reveal how the population responds to contamination, and more specifically, which population response parameters are being affected. In conjunction with analyses of their exposure to environmental media (water and sediment), and measurement of biomarkers of exposure and/or effects, analysis of population response parameters can contribute to a weight-of-evidence for, or against contaminant effects on the population. Growth, reproduction, and mortality of *C. fluminea* has been studied in the Delta (Foe and Knight, 1981; 1985; 1986), and elsewhere (Aldridge and McMahon, 1978). That information will provide background and reference information for the proposed study. However, to achieve the objectives of this study, sampling of clam population and sediments, analyses of contaminant concentrations in sediments and tissues, and biomarker studies (Task 3) must be performed synoptically from reference and contaminated locations. DWR's long-term benthic monitoring data includes abundances of the two benthic species, and will provide important information about population trends that will be useful in interpreting the results of this study.

Task 3: Evaluation of the influence of heavy metals and hydrophobic pesticides on health parameters (biomarkers) in populations of *G. daiberi* and *C. fluminea*: - The toxic effects of contaminants are often subtle, eventually leading to population decline, but not easily detectable and identifiable with conventional methods. Similar to health assessment in human medicine, it is important to use a combination of indicators for assessing the sublethal effects of pollutants on aquatic organisms. In recent years, histological, cellular and biochemical biomarkers have been successfully used in determining deleterious effects of pollutants in invertebrates and fish (Werner and Hinton 2000, Teh *et al.* 2000, Werner and Nagel, 1997). In this study, we will test the hypothesis that changes in stress protein (hsp70)

levels and metabolic enzyme activity, a decrease in lysosomal membrane integrity and available cellular energy (glycogen, ATP/ADP), and an increase in histopathologic lesions are indicative of exposure to and effect of mixtures of heavy metals and hydrophobic pesticides on populations of field collected *G. daiberi* and *C. fluminea*. Increased expression of stress proteins indicates the activation of the organisms cellular protein repair system by xenobiotic compounds (Hendrick and Hartl 1993, Sanders 1993, Bauman et al. 1993). A reduction in lysosomal integrity indicates sublethal cellular damage and signals a reduced ability to maintain normal cellular function (e.g. Lowe et al. 1995, Koehler and Pluta 1995, Giamberini and Pihan 1997, Werner et al. 1999). The adenylate energy charge (AEC) defined by Atkinson (1977) measures the energy capacity stored in cells and tissues of an organism (Dickson and Giesy 1982, Vetter and Hodson 1982, Zarogian and Johnson 1989, Thompson and Couture 1990). Stress caused by pollutants leads to an increase of cellular energy demand (Vetter and Hodson 1982). Histopathologic biomarkers are lesions in cells, tissues, or organs caused by exposure to infectious or toxic agents (Hinton et al. 1992, Teh et al. 1996, 1999). Histopathology has been used with both fish and aquatic invertebrates for the assessment of contaminant mediated adverse effects (Adams et al. 1989, Hinton et al. 1992, Teh et al. 1999). For example, histologic damage in reproductive organs can be directly linked to reproductive health and, consequently, population-level effects (Wester and Canton 1986). Histopathologic analysis is particularly relevant to field investigations (Meyers et al. 1994). The addition of enzyme-histochemical assays to a diagnostic repertoire provides information with respect to metabolic alterations that cannot be evaluated in routine histological sections. Enzyme histochemistry has been used to detect preneoplastic enzyme altered foci in livers of carcinogen-exposed fish, and to quantify heavy metal induced alterations in clams (Teh and Hinton 1993; Teh et al. 1999).

Task 4: Acute and chronic effects of dietary exposure to mixtures of heavy metals and hydrophobic pesticides in white sturgeon and juvenile chinook salmon: - In recent years, food chain transfer of sediment-associated pollutants via bioaccumulation and dietary uptake is receiving increased attention (Schlekat and Luoma 2000). We will test the hypothesis that dietary exposure to hydrophobic pesticides and heavy metals – singly or in mixture – causes adverse sublethal effects in two resident fish species of concern, white sturgeon and chinook salmon. In surface waters, heavy metals and hydrophobic organic contaminants partition preferentially to sediment particles and suspended matter. These xenobiotic compounds can be taken up and bioaccumulated by benthic and epibenthic invertebrates, who can then serve as vectors for transfer of potentially toxic concentrations of pollutants from sediments to higher trophic levels such as fish and, ultimately, to humans. Concentrations of metals and hydrophobic organic compounds in food organisms can be orders of magnitude higher than concentrations in water. Woodward et al (1994) concluded that trout accumulated copper, cadmium and arsenic predominately from food even in the presence of excess dissolved metals. Schlekat and Luoma point out that for the bivalve *Macoma balthica*, dietary exposure is more important than dissolved exposure, and studies on freshwater cladocerans and marine copepods showed reproductive effects when zooplankton were fed algal cells enriched with silver (Fisher and Hook 1997). Dietary exposure to selenium concentrations as low as 8 ug/g is widely accepted to cause teratogenic effects in fish and reproductive effects in wildfowl. In a recent pilot experiment done in our laboratory, dietary exposure of medaka fish to esfenvalerate resulted in decreased egg production and hatching success of embryos (unpublished data). Numerous studies have shown an inverse relationship between carboxyl

Figure 2



esterase activity and susceptibility to the toxic effect of organophosphates, carbamate and pyrethroids (Parkinson 1996). Results from other studies on interactive effects of xenobiotic compounds emphasize the need for more research in this area (Wellise et al. 1999, Pape-Linstrom and Lydy 1997, Bailey et al. 1997).

Task 5: Recommendations for pollutant management and monitoring: - The results of the field and laboratory studies will be synthesized to provide recommendations on management of sediments, heavy metals and hydrophobic pesticides to minimize aquatic toxicity and to develop monitoring approaches that could be adopted by state and federal programs. Management recommendations may focus on identification of compounds, which pose the greatest threat to resident fish and/or their invertebrate prey. Recommendations for monitoring programs may include a list of compounds of concern, in particular when present as mixtures, tools to predict bioavailability and risk to predator species, and recommendations for best management practices. Our goal is to make our results and conclusions accessible to environmental managers, farm advisors and pesticide users, in order to facilitate their integration into the development of adaptive management strategies.

Proposed Scope of Work

Location of The Project: Field work will be done in the Sacramento-San Joaquin Delta, east of Chipps Island, extending to Rio Vista on the Sacramento River and to Clifton Court and Buckley Cove (Ecological Management Zone 1). Present DWR sampling sites (D4, D16, D24, D28 C9, P8) are shown in Figure 2. Potential field stations are located in Contra Costa, San Joaquin, Solano and Sacramento Counties. As requested by CALFED, the County Board of Supervisors and Planning Department of these counties have been notified, and copies of the letters are attached. In addition, letters have been sent to the Delta Protection Commission and the Bay Conservation and Development Commission. Copies are attached.

Approach: Task 1: Bioaccumulation and pollutant transfer of sediment bound heavy metals and hydrophobic pesticides: Over a period of two years, we will carry out monthly collections of sediments and two common resident invertebrate species, *G. daiberi* and *C. fluminea*, from four field stations in the Sacramento-San Joaquin delta. Sampling site selection will be based on long-term monitoring data collected by the Department of Water Resources and available information on toxicity in the Delta. Chemical analyses of concentrations of hydrophobic pesticides and heavy metals will be performed on sediment and tissue samples. Results will be used to calculate bioconcentration factors, and to evaluate the influence of these toxicants on resident invertebrate population structure and health. Task 1 also includes chemical analyses of food and fish tissues in our laboratory feeding studies with white sturgeon and juvenile chinook salmon to measure bioaccumulation of these compounds via dietary uptake (Task 4). Pesticides will be measured by immunoassay or GC/MS (Shan et al., 1999). Assay validation will be conducted with a Hewlett-Packard Model 5890 GC equipped with a HP 5973 mass selective detector and a 30-m x 0.25 mm i.d. HP-5MS 5% phenyl methyl siloxane column. GC/MS will also be used for the detection of organochlorine compounds. For dietary exposures, accelerator mass spectrometry (AMS) will be used to measure pesticide concentrations in diet and fish tissues. Analyses will be performed in Dr. Shan's laboratory at UC Davis and Dr. Vogel's laboratory at the Center for AMS, Lawrence Livermore National Laboratory. This powerful method is highly sensitive, and is especially useful for compounds present at very low concentrations (Vogel et al.

1995). Heavy metals will be analyzed at the California Veterinary Diagnostics Laboratory, School of Veterinary Medicine, UC Davis, or in Dr. Tom Young's laboratory, Dept. of Civil and Environmental Engineering, UC Davis (see attached letter). Principal component analysis will be used to identify the dominant toxicants. We will closely collaborate with other research groups investigating the effects of dietary exposures to individual heavy metals (e.g. selenium and mercury, see letters of collaboration) on various fish species. In addition, we may join forces with Dr. D. Weston's group and decide to combine aqueous exposures to common pesticides with dietary exposures to heavy metals/hydrophobic pesticides. This decision would be based on Dr. Weston's results on direct effects of pesticides on juvenile salmon (see letters of collaboration).

Task 2: Evaluation of the influence of heavy metals and hydrophobic pesticides on population structure and dynamics of *G. daiberi* and *C. fluminea*: - Over a period of two years, benthic sampling at the four sites selected will be performed monthly in collaboration with DWR as part of their Compliance Monitoring Program. Growth and mortality rates of populations are the most commonly measured population response parameters, and are usually obtained by analysis of changes in the population age-structure. Methods originally developed for fisheries research (e.g. Von Bertalanffy 1938, Brody 1945, Ricker 1958) have been applied to aquatic and marine invertebrate populations (Breen and Fournier 1984, Ebert 1973, Macdonald and Pitcher 1979, Gage and Tyler 1981, Thompson *et al.* 1993). Since benthic invertebrates are generally of limited motility, analyses of growth and mortality may be conducted on "local" populations at specific site(s) rather than on the entire population. Benthic samples are collected from a boat using a Ponar grab. Additional trawls may be used to obtain sufficient numbers of epibenthic amphipods (Kaiser *et al.* 1994). The contents of each grab are screened and fixed with 10% buffered formalin containing Rose Bengal stain to facilitate identification of living material. A screen with smaller mesh size may be needed to retain newly settled juveniles. Since the sizes at recruitment are not known, preliminary samples will be collected and sieved through a series of 0.1 to 0.5 mm screens to determine which size collects all juvenile *C. fluminea* and *G. daiberi*. Following taxonomic identifications in DWR's contractor's laboratory, all specimens of *C. fluminea* and *G. daiberi* collected will be loaned to SFEI for size- frequency measurements. Size-frequency distributions will be generated from measurements of *C. fluminea* and *G. daiberi*. Shell length of *C. fluminea*, and total length of *G. daiberi* will be measured to the nearest 0.1 mm using an ocular micrometer on a dissecting microscope. Recruitment will be evidenced by the appearance of relatively numbers of organisms in the smallest size classes. Growth and mortality rates will be calculated from the size-frequency data using computer programs developed for use with Abalone (Fournier and Breen 1983, Breen and Fournier 1984) based on the numerical approach developed by Schnute and Fournier (1980). The programs use non-linear parameter estimation procedures to simultaneously fit a set of parameter values to the equations in the model. The methodology will provide estimates of comparative recruitment and standardized monthly growth and mortality estimates from areas with different levels of sediment contamination. Significant differences in the numbers of recruits, and growth and mortality coefficients generated between the reference and impacted sites will be evaluated using a repeated measures t- test.

Task 3: Evaluation of the influence of heavy metals and hydrophobic pesticides on health parameters (biomarkers) in populations of *G. daiberi* and *C. fluminea*: - We will investigate the influence of the above pollutants on invertebrate health by analyzing a suite of

histological and cellular indicators of deleterious effect in field collected *G. daiberi* and *C. fluminea*. Samples for biomarker analysis will be collected during three consecutive months in winter/spring and summer/fall over a period of two years. Task 3a: Histological and histochemical indicators: Tissues fixed in 10% buffered formalin are dehydrated, cleared and embedded in paraffin. Tissue blocks are cut into sections of 5-7 microns in thickness, then stained in hematoxylin (H) and eosin (E) for histopathologic analysis. The severity of histopathologic alterations is semi-quantitatively ranked based on the cytological alterations found in each organ. Enzyme- and immunohistochemical methods are followed to determine if changes in active transport (alkaline phosphatase), intracellular digestion (acid phosphatase), glucose cycle oxidation (glucose-6-phosphate dehydrogenase), glycogen storage (periodic acid-schiff reagent), and energy status (ATPase) can be assessed (Teh and Hinton, 1993, Teh et al 1999). Sections are stained using a Zymed LEICA ST5050 automated immunostainer. To detect changes in cell proliferation and apoptosis, tissue sections are treated separately with anti-PCNA (proliferating cell nuclear antigen) and ApopTag *in situ* Apoptosis detection kit (Dako, Carpinteria, California USA) to. All sections are counterstained with hematoxylin and examined under a light microscope.

Task 3b: Biochemical and cellular stress indicators: *Stress protein (hsp70) analysis:* Hsp70 proteins are analyzed using Western blotting techniques. A monoclonal antibody for hsp70 (1:500, Affinity Bioreagents MA3-001) is used as a probe. Bound antibody is visualized by a chemiluminescent substrate (CDP-Star, Tropix, Bedford, MA) and quantified by densitometry. *Lysosomal membrane integrity:* Serial cryostat sections (10 μ m) of the 'fat body' or hepatopancreas are incubated in 0.1 M citric buffer (pH 4.5) at 37°C for different time periods to determine the lysosomal destabilization time according to Köhler (1991). Lysosomal destabilization time, the time period of acid labilization needed to destabilize the membrane, marked by the maximum staining intensity of acid phosphatase in lysosomes, is assessed by image analysis. *Adenylate energy charge:* Nucleotides are extracted and quantified by high performance liquid chromatography (HPLC) on a reverse phase column with a counter ion. This method allows separation of the major nucleotides (ATP, ADP, AMP, GTP, GDP, GMP, UTP, UDP, UMP, IMP).

Task 4: Acute and chronic effects of dietary exposure to mixtures of heavy metals and hydrophobic pesticides in white sturgeon and juvenile chinook salmon:

Task 4a: We will perform feeding experiments in the laboratory. Exposure concentrations will reflect chemical concentrations measured in tissues of field collected invertebrates (Task 1 and other studies, see letters of collaboration). Fish will be obtained from Dr. Silas Hung, Dept of Animal Science, University of California Davis (white sturgeon) and California salmon hatcheries (juvenile salmon), and will be exposed for a minimum of 4 weeks. Water quality parameters and mortality will be recorded daily. Task 4b: Histological and histochemical indicators of pollutant effects in fish will be measured as described above (Task 3a). Task 4c: Liver samples will be used for determination of carboxyl esterase activity. Standard assays examining the ability to hydrolyze *p*-nitrophenylacetate (PNPA) will be conducted as well as assays using several esterase substrates that we have synthesized in our laboratory to probe esterase diversity (Huang et al., 1996). Kinetic assays will be run using a microplate reader (Molecular Devices, Palo Alto, CA). All activities will be corrected for background hydrolysis and specific activities normalized for protein concentration using methods of Bradford. Task 4d: Cellular indicators of metabolic stress and deleterious effects (stress proteins, lysosomal membrane integrity,

adenylate energy charge) be measured as described above (Task 3b). Appropriate immunological endpoints such as macrophage activity or cortisol levels, and indicators of endocrine/reproductive effects such as choriogenin or vitellogenin will be chosen for analysis based on preliminary experiments and results obtained in ongoing studies.

Data Handling and Storage: Data will be collected and stored in databases at SFEI and UCD. It will be accessible directly or via progress reports posted on the internet.

Expected Products and Outcomes: This project will yield important information on acute and chronic effects of sediment-associated hydrophobic pesticides and heavy metals, singly and in mixtures, on invertebrate and fish species resident in the Sacramento-San Joaquin Delta. We will focus on the bioaccumulation of sediment associated contaminants by benthic and epibenthic invertebrates and food chain transfer of these contaminant mixtures to two fish species, white sturgeon and juvenile chinook salmon, and their potential toxic effects on these species. Information obtained will be published in peer-reviewed scientific journals, and made available to environmental managers, farm advisors and pesticide users via reports, and the internet. We will also present our data at both local citizens and local and national scientific meetings, and produce 'fact sheets' for local distribution. We intend to work with environmental managers to facilitate the integration of our findings in management strategies.

Project Schedule: The proposed project consists of two components, a field study on invertebrate species, and a laboratory feeding study on two fish species. The experimental design of the dietary exposures will be based, in part, on data collected during the first year of the project's field component.

Table 1: Project schedule

Task	2000 OND	2001 JFMAMJ JASOND	2002 JFMAMJ JASOND	2003 JFMAMJ JAS
#1: Bioaccumulation	XX	XXXXXXXXXXXXX	XXXXXXXXXXXXX	
#2: Invertebrate population structure	XX	XXXXXXXXXXXXX	XXXXXXXXXXXXX	
#3: Invertebrate population health	X	XXXXXXXXXXXXX	XXXXXXXXXXXXX	
#4: Dietary exposure and effects in fish		XXX	XXXXXXXXXXXXX	XXXXXXX
#5: Final report and recommendations				XXX

Monthly field sampling will commence at the earliest possible date, and will continue for the first two years of the project in collaboration with the California Department of Water Resources. Laboratory feeding studies will begin after one year of invertebrate data collection. Work on dietary uptake of contaminants and acute and chronic effects in white sturgeon and juvenile salmon will continue until approximately 2 months from project termination. The last three months will be spent on data analyses and interpretation, final report writing and formulation of recommendations.

Feasibility

There are several unique attributes of our project team and the proposed work that make the project feasible within the three-year period.

Sampling: The California Dept. of Water Resources will assist us in getting sediment and invertebrate samples within their ongoing benthic monitoring program in the Delta. Their expertise, technical equipment and sampling experience will greatly facilitate our efforts during the first and second year of the study. To save ship time, we plan to provide a field assistant and an additional aluminum chute for processing benthic samples in the field. By collecting data over a two-year period, we will be able to compensate for weather related problems that could affect sampling success.

Analytical capabilities: Dr. Shan and Dr. Vogel have unparalleled breadth in pesticide analytical capability both at their facilities at UC Davis and at Lawrence Livermore National Lab. They are able to analyze pesticides both by gas chromatography, immunoassay and accelerator mass spectrometry (AMS). AMS will enable us to quantify concentrations of pesticides below detection limits of other analytical methods. These low concentrations are especially important for endocrine disrupting chemicals. Both researchers have extensive experience in their respective techniques, which will ensure that samples are processed within the allocated time frame. Heavy metal analysis will be performed at the California Veterinary Diagnostic Laboratory, University of California, Davis School of Veterinary Medicine, whose mission is to provide the highest quality diagnostic laboratory support services. We will also consult with Dr. T. Young (Dept. Civil and Environmental Engineering, UCD) and Dr. T. Suchanek (UCD) regarding low level detection of heavy metals and mercury speciation to obtain the best available information and support.

Population structure and dynamics: Dr. Thompson (San Francisco Estuary Institute) is highly skilled and experienced in conducting monitoring studies throughout San Francisco Bay (please see 'Qualifications'). Analytical methods for population structure and dynamics, and data processing are well established. The San Francisco Estuary Institute is a private, not-for profit organization with the mission of providing scientific information to environmental managers and regulators. They are located on the UC Berkeley Richmond Field Station in Richmond. Their facilities include Information Technology facility, including servers for the local network, databases, GIS, and world wide web information. A wet laboratory is used for processing samples and maintaining living organisms. It is equipped with aquaria and microscopes necessary to conduct the proposed work.

Invertebrate population health: Both Drs. Teh and Werner have extensive experience in the analysis of the proposed histological, cellular and biochemical indicators in both invertebrates and fish (see 'Qualifications'). The proposed study will be carried out in School of Veterinary Medicine laboratories and the Aquatic Toxicology Exposure Facility (ATEF)

of Drs. Hinton, Werner and Teh on the UC Davis campus. The ATEF is a facility for aquatic toxicologic investigations, which include exposure of fish and invertebrates to numerous toxicants. Biochemical and cellular imaging studies will be performed in a general purpose laboratory equipped for processing, microscopy, and biochemical and molecular toxicology.

Laboratory feeding studies: Extensive experience in fish culture, maintenance and nutrition is available at UCD. Dr. Silas Hung is an experienced fish physiologist who specializes in sturgeon, and has agreed to provide expertise and white sturgeon for the exposure experiments. Dr. Mark Okihiro is highly experienced in fish pathology and maintenance, and will supervise the feeding studies. Facilities for the exposure experiments are available at the Institute of Ecology, UCD, and the Institute of Environmental Toxicology and Health, UCD. The preparation laboratory is equipped for fish rearing and biological sample preparation. Purified and test diets, and their chemical and toxicant contents, will be prepared and verified in the laboratory which is equipped with several feed mixers, a steam generator connected to a California Laboratory Pellet Mill, HPLC, GLC, and spectrophotometer.

Availability of test fish species: We have contacted the Nimbus and Feather River fish hatcheries regarding the availability of juvenile chinook salmon, and have been assured that they can provide the fish needed for the feeding studies. Dr. Silas Hung (see attached letter of collaboration) will provide white sturgeon.

Relationship to ERP Goals and CVPIA Priorities

ERP Goal 1. At-risk species: All runs of chinook salmon are categorized as at-risk species. There is reason to believe that juveniles that are in the system for rearing are exposed to a multitude of chemical contaminants, both in the water column and through their diet. To date, the effects of mixtures of contaminants are largely unknown. However, studies on binary mixtures of pesticides or metals and pesticides have provided reason for concern. White sturgeon are close relatives of the endangered green sturgeon, and uses the same food resources as the endangered species. ERP Goal 5: Clams act as vectors for transfer of contaminants from sediments into the food-chain and across trophic systems. This project will investigate the impact of the established non-native clam species *Corbicula fluminea* on an important fish species, white sturgeon. ERP Goal 6: Sediment and Water Quality. This study addresses critical issues related to sediment quality. Sediments are sinks for many contaminants. These contaminants can be re-mobilized and transferred into the biota via benthic organisms. We need to develop an understanding of how critical this is for invertebrate populations, who are an integral part of the system, and for the fish that feed on them. Indirect or chronic effects can lead to a decline in growth or productivity of both invertebrates and fish. Especially in light of newly introduced pesticides such as the pyrethroid insecticides, we need to know how these compounds can affect elements of the ecosystem. Our study will address bioaccumulation and food chain transfer of heavy metals (e.g. Hg, Se, Cu, Cd, Ag) and hydrophobic pesticides (chlorpyrifos, organochlorines (DDT and metabolites) and pyrethroids) and the potential joint effects – acute and chronic - of mixtures of these compounds on invertebrate species, juvenile salmon and white sturgeon.

CVPIA Priorities: This project contributes to a better understanding of the ecological impacts of sediment-associated contaminants. It will provide information on the significance of bioaccumulation and dietary contaminant transfer to special-status fish species, and help focus remediation measures directed at reducing contaminant input to the system, thus

providing ecosystem-wide benefits. Our collaboration with the California Dept. of Water Resources and other research groups will make this project highly cost-effective. We have the support of numerous other CALFED investigators, and the California Prune Board, which will ascertain good information flow between projects and interested public parties. In addition, our interaction with the UC Davis Statewide Integrated Pest Management Program and the University Extension will ensure that our results will reach the farming community.

Relationship to Other Ecosystem Restoration Projects

There are several ongoing CALFED projects whose goals are complementary to our proposed project. We intend to interact with these research groups (PIs: Dr. Sam Luoma, Dr. F. Zalom, Dr. W. Bennett, Dr. S. Hung and Dr. D. Weston) on a regular basis to ensure that our experiments will be designed based on the latest scientific findings. Dr. Luoma's letter of collaboration and support is attached. He is PI on CALFED project F1-103, "Assessing Impacts of Selenium on Restoration of the San Francisco Bay-Delta Ecosystem". The involvement of two of our investigators in several CALFED projects will contribute to unhindered information flow between them. Dr. Werner is has been involved in Dr. Zaloms study on 'Alternative Practices for Reducing Pesticide Impacts on Water Quality'. She is a collaborator on CALFED study # 99-N08 'Pesticide Effects on Fish and their Food Resources in the Sacramento-San Joaquin Delta'. Dr. Teh is a collaborator on CALFED studies # B81650 'Role of Contaminants in the Decline of Delta Smelt in the Sacramento-San Joaquin Estuary' and # NFWF99-N07 'Chronic Toxicity of Environmental Contaminants in Sacramento Splittail (*Pogonichthys macrolepidotus*): A Biomarker Approach'. Dr. Werner is also a member of the Urban CALFED Advisory Committee for the City of Modesto program to reduce water quality impacts from urban use of pesticides.

System-Wide Ecosystem Benefits

We have focused our efforts on salmon, sturgeon and two invertebrate species resident in the Delta and part of their natural diet. Although this is a restrictive scenario, we will be able to quantify the bioavailability of important groups of sediment-associated contaminants, and measure their effects on invertebrate populations and – via food-chain transfer – on two important fish species. Our work will help identify compounds of concern, and provide environmental managers with information that will allow them to focus remediation efforts directed at reducing contaminant input to the Delta. Presently, there is no information available on the effects of dietary exposure to pyrethroid pesticides – singly or in combination with heavy metals, OP pesticides and/or organochlorine pesticides -. However, agricultural application of pyrethroids in the Sacramento-San Joaquin watershed and delta is increasing. Very little information is available on the interactive effects of contaminant mixtures, but we know that aquatic organisms are exposed simultaneously to many potentially toxic compounds. Our findings will provide a better understanding of the significance of dietary exposures, and sublethal toxic effects of sediment-associated heavy metals and pesticides to invertebrates, juvenile salmon and white sturgeon. These results may be extrapolated to other fish species feeding on the same food sources. They will also provide a basis for assessing potential impacts on other fish species, based on contaminant concentrations in their food source, thus providing environmental managers with better information to design monitoring programs and perform risk assessments.

Applicant Qualifications

Dr. Ingeborg Werner, (UC Davis, Dept. of Anatomy, Physiology and Cell Biology, School of Veterinary Medicine) will act as Project Manager for the proposed work, and will be the primary contact person for CALFED. She will be responsible for coordination of tasks among the other project participants. She will also share the primary technical responsibilities in Tasks 3 and 4 (acute and chronic effects of pollutants in invertebrates and fish) with Dr. Teh, and be responsible for coordinating outreach efforts (presentations), reporting and recommendations. Dr. Werner holds a master's degree in limnology from University of Freiburg, Germany, and a doctoral degree in ecotoxicology ('magna cum laude') from University of Mainz, Germany. She has 10 years of experience in biomarker research and aquatic toxicity testing, and is part of the research faculty at UC Davis. Her research interests focus on sublethal effects of pollutants in aquatic invertebrates and fish, and the development and application of toxicity tests using chronic endpoints and cellular and biochemical biomarkers at various levels of organisation. Other components of her work include aquatic monitoring studies to assess pesticide toxicity in the Delta, impact and efficacy of alternative pest control methods in the Sacramento/San Joaquin watershed, toxicity of MTBE to freshwater organisms, and toxicity of stormwater runoff in California urban areas. Present work is applying the biomarker approach to the assessment of sediment toxicity in collaboration with researchers from UC Davis, Department of Civil and Environmental Engineering, SFEI, USGS and Point Reyes Bird Observatory (CISNet, EPA grant# 98-NCERQA-R1). She is collaborator on CALFED project # 99-N08 (Pesticide Effects on Fish and their Food Resources in the Sacramento-San Joaquin Delta), and on a CALTRANS study on toxic effects of storm runoff from California highways.

Dr. Swee J. Teh is a comparative pathologist with 14 years of extensive field and laboratory research experience in ecotoxicology and biomarker studies. He is experienced in managing projects and contracts amounting to a total of >\$1 millions per year. He will be primarily responsible for: 1) the histopathological and histochemical assessment of fish and invertebrate tissues obtained from the field (Task 3a); 2) the histopathological and histochemical assessment of fish exposed to chemical mixtures in the laboratory (Task 4b); 3) the interpretation and integration of all histopathological and histochemical data and the submission of quarterly and annual reports with Drs Werner, Thompson, and Shan (Task 5). He has been Principle Investigator on and managed grants from various Federal agencies, including USEPA, NCI, and CALFED. Dr. Teh is primary or co-author on over two dozens peer-reviewed publications related to invertebrate and fish histopathology, histochemistry, and ecotoxicology, including Teh and Hinton (1993 and 1998) and Teh *et al.* (1997 and 1999).

Bruce E. Thompson, Ph.D. Bruce Thompson was born in Chico, California, is a graduate of California State University, Fresno, received his M.A. from the Moss Landing Marine Laboratory, and his Ph.D. in biological sciences from the University of Southern California in 1982. Dr. Thompson is the Senior Scientist at the San Francisco Estuary Institute in Richmond, CA. where he directs the Estuary Monitoring and Research Program and is the Chief Scientist for the San Francisco Estuary Regional Monitoring Program (RMP). His research has included field and laboratory studies of the ecology of benthic communities and species off southern California and in the San Francisco Bay-Delta, and how they are affected by contamination. He has also worked on development of monitoring programs and ecological indicators. He is currently the Principal Investigator for the RMP.

Benthic Pilot Study and Co-Investigator on the EPA funded CISNet San Pablo Bay Program in collaboration with UC Davis. He has been a participant in the development of the Comprehensive Monitoring, Assessment, and Research Program for CALFED and is currently participating in their Management Level Indicators Project. He has participated on the Interagency Ecological Programs Management Team, the Science Advisory Board for the State's Bay Protection and Toxic Cleanup Program, and the Technical Advisory Panel for the CALFED Delta Dredge Material Re-use Project. He was a member of the Santa Monica Bay Restoration Project's Technical Advisory Committee, 1988-93, a member of the National Benthic Experts Panel convened by the Washington Department of Ecology in Seattle in 1993, and served as a Sediment Toxicity Essay Expert Reviewer for NOAA in 1999. Dr. Thompson has published many peer-reviewed journal articles, a book chapter, and numerous technical reports on his research. He is a member of the Society of Environmental Toxicology and Chemistry and the Estuarine Research Federation. Dr. Thompson will be responsible for the analysis of invertebrate population structure and dynamics in our field study (Task 2), and for integrating his results into reports and recommendations.

Dr. Guomin Shan received his Ph.D. degree in entomology and chemistry from Louisiana State University with Dr. Jim Ottea, studying the development of diagnostic technology to detect mechanisms of pyrethroid resistance that included synthesis of pyrethroid metabolites and pesticide metabolism studies in insects. He obtained a Master's degree in environmental toxicology from Beijing Agricultural University, China where his thesis was entitled "Development of ELISA for determination of triazine herbicide residue in soil and water." Dr. Shan has been working in Prof. Bruce D. Hammock's laboratory for 2 years. His research interests focus on development of compound and class specific immunoassays for the detection of environmental contaminants (such as dioxins and pesticides) in human and environmental samples, the study of pesticide metabolism in insects, human, and the environment by accelerator mass spectrometry (AMS), and the development of rapid, miniaturized biosensors (antibody and cell-based) for use in the detection of pesticides and pathogens in environment and food safety. Dr. Shan will be responsible for chemical analyses of sediments, invertebrates, diet and fish tissues (Task 1) by immunoassay, GC/MS and AMS, and for integrating his results into reports and recommendations.

Budget

The budget is shown in the attached tables with each table representing the budget for a single institution. The San Francisco Estuary Institute is participating in this project as a subcontractor to the University of California Davis (UCD), and the total dollar value of its subcontract is included in the UCD budget under the category 'service contracts'.

Task 1: Dr. Guomin Shan will devote 25% of his time in year 1 to scale up and train a post graduate researcher (PGR) who will commit 50% of his time to this project. In years 2 and 3, Dr. Shan's role will be project direction and supervision and thus, his time commitment will fall to 10%. The PGR will work with Dr. Shan in chemical analyses using immunoassay and GC/MS, and in AMS sample preparation. *Equipment:* A centrifuge and muffle oven will be required to prepare samples for AMS analysis. *Supplies:* Consumable supplies include glassware, plastic ware, microtiter plates, biochemicals, chemicals, immunochemicals, thin layer plates, laboratory solvents, HPLC supplies, electrophoretic supplies, computer supplies, liquid scintillation vials and cocktail, radiotracers and

chromatography columns. In years two and three we are requesting funds for recharge of instrument time for the accelerator mass spectrometer at LLNL (ca. \$20,000). *Travel:* The funding is for trips to Lawrence Livermore National Lab. for AMS measurement. **Task 2:** San Francisco Estuary Institute's (SFEI) salaries are based on audited and accepted US EPA rates. All figures are based on estimates of 2 hours per sample for sorting, 3 hours per sample for size measurement, and 2 hours per sample for iterative determination of growth and mortality coefficients including preparation of graphics. Forty hours (40) during year one are allocated for method development, adaptation of growth and mortality analysis of computer programs. Thirty (30) hours per year for coordination and planning and thirty (30) during Year 1 for progress reporting. One hundred (100) hours are anticipated in Year 2 for preparation of the final report. *Equipment:* \$2000 has been requested for additional chute for processing benthic samples on the DWR sampling vessel. Supplies include an ocular micrometer for dissecting microscopic, and screens needed to collect the smallest juveniles from benthic samples. *Travel:* Travel for sampling and meeting with UC Davis collaborators are slated at \$800/per year for 2 years. Overhead (indirect) charges are figured as total cost of salaries and fringe benefits multiplied by 35.9%. **Tasks 3 and 4:** Salary costs include those for the principal investigators and employees. Dr. Teh will serve as a Co-Principal Investigator directing the histopathology component of the project. Direct labor hours reflect a 2304-hr commitment of Dr. Teh on these (Task 3a and 4b) and his primary task of evaluating and interpreting the large number of invertebrate and fish histopathological and histochemical preparations. Dr. Teh requires one assistant, a 4320-hr commitment of a laboratory Assistant IV (C. Teh) for histological and histochemical processing. Costs for supplies include laboratory reagents for histology, histochemistry, laboratory exposures, hazardous waste disposal, computer software, and general laboratory/ office operation related to the project. Travel funds for research, project meetings and presentations at the national conference of a professional society have been included. Dr. Werner will supervise and train personnel for studies on cellular and biochemical biomarkers. A post-graduate researcher (TBN) with a 50% time commitment, and a laboratory assistant III at 25% time have been allocated to tasks 3b and task 4d. The budget for Task 4a reflects a 25% time commitment of a post-doctoral researcher (Dr. M. Okihira) and a 50% time commitment of 4 student assistants. Costs for Task 4c include a graduate student salary at 25% time (C. Wheelock) and student fees. Money allocated for supplies includes the cost for analytical chemistry (heavy metals) in sediment, diet and tissue samples for an estimated 400-500 samples (ca. \$25,000). Material and supplies required to perform the proposed research include aquarium supplies, exposure chambers, hazardous waste disposal, reagents and laboratory supplies for biochemical analyses, antibodies, embedding supplies and fixatives, dissecting instruments, photographic material for documentation of results, and data analysis software. **Task 5:** The budget for Task 5 reflects salaries and benefits for principal investigators, office supplies, travel expenses between laboratories and to participate in local and national conferences. The **Project Management Task**, budgeted only for the prime contractor (I. Werner, UCD), includes time required to prepare quarterly reports, respond to requests for information from CALFED or member agencies, give oral presentations to CALFED, track progress by the subcontractor, and local travel expenses to CALFED offices or locations of collaborators. *COLA:* Years 2 and 3 of the budget include a 3% (SFEI, UCD-Dept. of Entomology) and 4% (UCD-School of Veterinary Medicine) Cost of Living Adjustment (COLA). *UCD Overhead:* Indirect costs for UCD will depend upon whether the source of funding is state or federal,

and two alternative budgets are provided. If state funds, an indirect rate of 10% is applied against direct costs excluding equipment and graduate student fees. A 10% indirect rate is also applied to subcontracts up to \$25,000, beyond which no indirect costs are applied. If federal funds are used for this project, the indirect cost rate at UC Davis is 46.5% (year 1), 48% (year 2) and 48.5% (year 3).

Local Involvement

We are pleased that the California Department of Water Resources is supporting our efforts by collaborating with our project team. Their team's knowledge and experience will be invaluable in designing the field program, and their technical assistance in sampling benthic invertebrates will ensure the success of the project.

We have developed our study in consultation with state resource managers and members of academia, and we look forward to a continuing exchange of information throughout the study. Our efforts to integrate relevant data already obtained or presently being generated by other research groups will ensure that the outcome of this project is relevant and applicable for environmental managers and monitoring programs. Letters of support are attached to indicate awareness of and support for our work from the following:

- Zachary Hymanson, California Department of Water Resources
- John Vogel, Lawrence Livermore National Laboratory
- Gary L. Obenauf, Director of Research, California Prune Board
- John S. Sanders, Branch Chief, Department of Pesticide Regulation
- Sam Luoma, U.S. Geological Survey, Menlo Park
- Silas Hung, Dept. of Animal Science, UC Davis
- Frank Zalom, Director, Statewide Integrated Pest Management Program, UC Davis
- Tom Suchanek, Dept. of Wildlife, Fish and Conservation Biology, UC Davis
- Tom Young, Dept. of Civil and Environmental Engineering, UC Davis
- Don Weston, Dept. of Integrated Biology, UC Berkeley
- Bill Bennett, John Muir Institute of the Environment, UC Davis

We anticipate that our results will be of considerable interest to a broad audience including the scientific community, resource management agencies, pesticide manufacturers and users. We will be happy to present seminars on project results in the Sacramento and Delta area, and will work with CALFED in developing the format and public announcements for these seminars. We anticipate agency staff and the scientific community will be reached by oral presentations at local environmental conferences (e.g. State of the Estuary Conference, NorCal SETAC, IEP meetings). In addition, we will publish the results in both peer-reviewed literature and local forums such as the IEP Newsletter and Estuary.

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ANNUAL AND TOTAL BUDGET - State Funds
University of California, Davis (PI: I. Werner)

University of California, Davis (Pl: I. Werner)												
			Subject to Overhead					Exempt from Overhead				
Year	Task	Hours	Salary	Benefits	Travel	Supplies	Service Contracts	Overhead	Equipment	Student Fees	Total Cost	
Year 1	Task 1	1,440	26,525	7,916	500	6,750		4,169	5,500		51,360	
	Task 2 (see attached*)	456					32,248	2,500	2,000		36,748	
	Task 3											
	Subtask 3a	1,440	33,072	6,614	500	18,000		5,819			64,005	
	Subtask 3b	1,824	38,192	6,967	500	15,000		6,066			66,725	
	Project	192	5,959	1,013	1000	500		847			9,319	
	Management											
Total Cost Year 1		5,352	103,748	22,510	2,500	40,250	32,248	19,401	7,500	0	228,157	
Year 2	Task 1	1,152	20,106	5,556	500	15,400		4,156			45,718	
	Task 2 (see attached*)	496					35,059				35,059	
	Task 3											
	Subtask 3a	1,440	34,395	6,879	500	10,000		5,177			56,951	
	Subtask 3b	1,824	39,720	6,967	500	10,000		5,719			62,905	
	Task 4											
	Subtask 4a	2,400	23,016	2,302		3,000		2,832			31,150	
	Subtask 4b	1,440	34,395	6,879	500	15,000		5,677			62,451	
	Subtask 4c	480	7,313	1,243		1,500		1,006		2,420	13,482	
	Subtask 4d	1,632	33,522	6,967	500	15,000		5,599			61,588	

	Project	192	6,198	1,054	1000	500		875			9,626
	Management										
Total Cost Year 2		11,056	198,664	37,847	3,500	70,400	35,059	31,041	0	2,420	378,930
Year 3	Task 1	1,152	20,709	5,722	500	15,400		4,233			46,564
	Task 4										
	Subtask 4a	2,400	23,937	2,394		3,000		2,933			32,264
	Subtask 4b	1,440	33,072	6,614	500	15,000		5,519			60,705
	Subtask 4c	480	7,606	1,293		1,500		1,040		2,420	13,859
	Subtask 4d	1,632	34,863	6,967	500	15,000		5,733			63,063
	Task 5	672	22,273	3,786	500	500		2,706			29,765
	Project	192	6,445	1,096	1000	500		904			9,945
	Management										
Total Cost Year 3		7,968	148,905	27,873	3,000	50,900	0	23,068	0	2,420	256,165
Total Project Cost		24,376	451,317	88,230	9,000	161,550	67,307	73,510	7,500	4,840	863,253

* Subcontract costs exceeding \$25,000 are exempt from overhead charged by University of California, Davis.

ANNUAL AND TOTAL BUDGET - Federal Funds
University of California (Pl: I. Werner)

Year	Task	Subject to Overhead			Exempt from Overhead				Total Cost
		Hours	Salary	Benefits	Travel	Supplies	Service Contracts	Overhead	
Year 1	Task 1	1,440	26,525	7,916	500	6,750		19,386	66,577
	Task 2 (see attached*)	456						11,625	45,873
	Task 3								
	Subtask 3a	1,440	33,072	6,614	500	18,000		27,057	85,243
	Subtask 3b	1,824	38,192	6,967	500	15,000		28,206	88,865
	Project	192	5,959	1,013	1000	500		3,940	12,412
	Management								
Total Cost Year 1		5,352	103,748	22,510	2,500	40,250	32,248	90,214	298,970
Year 2	Task 1	1,152	20,106	5,556	500	15,400		19,950	61,512
	Task 2 (see attached*)	496					35,059		35,059
	Task 3								
	Subtask 3a	1,440	34,395	6,879	500	10,000		24,851	76,625
	Subtask 3b	1,824	39,720	6,967	500	10,000		27,450	84,636
	Task 4								
	Subtask 4a	2,400	23,016	2,302		3,000		13,593	41,911
	Subtask 4b	1,440	34,395	6,879	500	15,000		27,251	84,025
	Subtask 4c	480	7,313	1,243		1,500		4,827	17,303
	Subtask 4d	1,632	33,522	6,967	500	15,000		26,875	82,864

QUARTERLY BUDGET - State Funds
University of California, Davis (PI: Ingeborg Werner, Ph.D.)

Tasks	Quarter 1 Oct-Dec 2000	Quarter 2 Jan-Mar 2001	Quarter 3 Apr-Jun 2001	Quarter 4 Jul-Sep 2001	Year 1 Total
Task 1	16,965	11,465	11,465	11,465	51,360
Task 2	11,797	8,627	6,691	9,633	36,748
Task 3a	16,002	16,001	16,001	16,001	64,005
Task 3b	16,682	16,681	16,681	16,681	66,725
Task 4	0	0	0	0	0
Task 5	0	0	0	0	0
Project Managem.	2,330	2,330	2,330	2,329	9,319
TOTAL	63,776	55,104	53,168	56,109	228,157

Tasks	Quarter 1 Oct-Dec 2001	Quarter 2 Jan-Mar 2002	Quarter 3 Apr-Jun 2002	Quarter 4 Jul-Sep 2002	Year 2 Total
Task 1	11,430	11,430	11,429	11,429	45,718
Task 2	8,765	8,765	8,765	8,764	35,059
Task 3a	14,238	14,238	14,238	14,237	56,951
Task 3b	15,726	15,726	15,726	15,727	62,905
Task 4a	11,682	3,893	11,682	3,893	31,150
Task 4b	15,613	15,613	15,613	15,612	62,451
Task 4c	5,186	2,766	2,765	2,765	13,482
Task 4d	15,397	15,397	15,397	15,397	61,588
Task 5	0	0	0	0	0
Project Managem.	2,407	2,407	2,406	2,406	9,626
TOTAL	100,444	90,235	98,021	90,230	378,930

Tasks	Quarter 1 Oct-Dec 2002	Quarter 2 Jan-Mar 2003	Quarter 3 Apr-Jun 2003	Quarter 4 Jul-Sep 2003	Year 3 Total	Grand Totals
Task 1	11,641	11,641	11,641	11,641	46,564	143,642
Task 2	0	0	0	0	0	71,807
Task 3a	0	0	0	0	0	120,956
Task 3b	0	0	0	0	0	129,630
Task 4a	12,099	4,033	12,099	4,033	32,264	63,414
Task 4b	15,176	15,176	15,176	15,177	60,705	123,156
Task 4c	5,280	2,860	2,860	2,859	13,859	27,341
Task 4d	15,766	15,766	15,766	15,765	63,063	124,651
Task 5	7,441	7,441	7,441	7,442	29,765	29,765
Project Managem.	2,486	2,486	2,486	2,487	9,945	28,890
TOTAL	69,889	59,403	67,469	59,404	256,165	863,252

QUARTERLY BUDGET - Federal Funds
University of California, Davis (PI: Ingeborg Werner, Ph.D.)

Tasks	Quarter 1 Oct-Dec 2000	Quarter 2 Jan-Mar 2001	Quarter 3 Apr-Jun 2001	Quarter 4 Jul-Sep 2001	Year 1 Total
Task 1	20,769	15,269	15,269	15,270	66,577
Task 2	14,078	10,908	8,972	11,915	45,873
Task 3a	21,311	21,311	21,311	21,310	85,243
Task 3b	22,216	22,216	22,216	22,217	88,865
Task 4	0	0	0	0	0
Task 5	0	0	0	0	0
Project Managem.	3,103	3,103	3,103	3,103	12,412
TOTAL	81,477	72,807	70,871	73,815	298,970

Tasks	Quarter 1 Oct-Dec 2001	Quarter 2 Jan-Mar 2002	Quarter 3 Apr-Jun 2002	Quarter 4 Jul-Sep 2002	Year 2 Total
Task 1	15,378	15,378	15,378	15,378	61,512
Task 2	8,765	8,765	8,765	8,764	35,059
Task 3a	19,156	19,156	19,156	19,157	76,625
Task 3b	21,159	21,159	21,159	21,159	84,636
Task 4a	15,717	5,239	15,717	5,238	41,911
Task 4b	21,006	21,006	21,006	21,007	84,025
Task 4c	6,141	3,721	3,721	3,720	17,303
Task 4d	20,716	20,716	20,716	20,716	82,864
Task 5	0	0	0	0	0
Project Managem.	3,238	3,238	3,238	3,238	12,952
TOTAL	131,276	118,378	128,856	118,377	496,887

Tasks	Quarter 1 Oct-Dec 2002	Quarter 2 Jan-Mar 2003	Quarter 3 Apr-Jun 2003	Quarter 4 Jul-Sep 2003	Year 3 Total	Grand Totals
Task 1	15,716	15,716	15,716	15,714	62,862	190,951
Task 2	0	0	0	0	0	80,932
Task 3a	0	0	0	0	0	161,868
Task 3b	0	0	0	0	0	173,501
Task 4a	16,333	5,445	16,333	5,445	43,556	85,467
Task 4b	20,488	20,488	20,488	20,488	81,952	165,977
Task 4c	6,281	3,861	3,861	3,860	17,863	35,166
Task 4d	21,284	21,284	21,284	21,283	85,135	167,999
Task 5	10,046	10,046	10,046	10,045	40,183	40,183
Project Managem.	3,357	3,357	3,357	3,355	13,426	38,790
TOTAL	93,505	80,197	91,085	80,190	344,977	1,140,834

San Francisco Estuary Institute
Annual and Total Budget - State and Federal Funds

Year	Task	Hours	Subject to Overhead					Exempt from Overhead			Total Cost
			Salary	Benefits	Travel	Supplies	Service Contracts	Overhead	Equipment	Student Fees	
Year 1	Task 1	0	0	0	0	0	0	0	0	0	0
	Task 2	456	18,819	3,474	800	1,150		8,005	0		32,248
	Task 3	0	0	0	0	0		0	0		0
Total Cost Year 1		456	18,819	3,474	800	1,150	0	8,005	0	0	32,248
Year 2	Task 1	0	0	0	0	0		0	0		0
	Task 2	496	21,279	3,928	800	0		9,052	0		35,059
	Task 3	0	0	0	0	0		0	0		0
	Task 4	0	0	0	0	0		0	0		0
Total Cost Year 2		496	21,279	3,928	800	0	0	9,052	0	0	35,059
Total Project Cost		952	40,098	7,402	1,600	1,150	0	17,057	0	0	67,307

QUARTERLY BUDGET - Federal and State Funds
San Francisco Estuary Institute

Tasks	Quarter 1 Oct-Dec 2000	Quarter 2 Jan-Mar 2001	Quarter 3 Apr-Jun 2001	Quarter 4 Jul-Sep 2001	Year 1 Total
Task 1	0	0	0	0	0
Task 2	9,172	8,002	6,066	9,008	32,248
Task 3a	0	0	0	0	0
Task 3b	0	0	0	0	0
Task 4	0	0	0	0	0
Task 5	0	0	0	0	0
Project Managem.	0	0	0	0	0
TOTAL	9,172	8,002	6,066	9,008	32,248

Tasks	Quarter 1 Oct-Dec 2001	Quarter 2 Jan-Mar 2002	Quarter 3 Apr-Jun 2002	Quarter 4 Jul-Sep 2002	Year 2 Total
Task 1	0	0	0	0	0
Task 2	8,065	8,065	8,065	10,864	35,059
Task 3a	0	0	0	0	0
Task 3b	0	0	0	0	0
Task 4a	0	0	0	0	0
Task 4b	0	0	0	0	0
Task 4c	0	0	0	0	0
Task 4d	0	0	0	0	0
Task 5	0	0	0	0	0
Project Managem.	0	0	0	0	0
TOTAL	8,065	8,065	8,065	10,864	35,059

Tasks	Quarter 1 Oct-Dec 2002	Quarter 2 Jan-Mar 2003	Quarter 3 Apr-Jun 2003	Quarter 4 Jul-Sep 2003	Year 3 Total	Grand Totals
Task 1	0	0	0	0	0	0
Task 2	0	0	0	0	0	67,307
Task 3a	0	0	0	0	0	0
Task 3b	0	0	0	0	0	0
Task 4a	0	0	0	0	0	0
Task 4b	0	0	0	0	0	0
Task 4c	0	0	0	0	0	0
Task 4d	0	0	0	0	0	0
Task 5	0	0	0	0	0	0
Project Managem.	0	0	0	0	0	0
TOTAL	0	0	0	0	0	67,307

San Francisco Estuary Institute



80 Richmond Field Station

325 South 46th Street
Richmond, California 94804
Office (510) 231-9539
Fax (510) 231-9414

May 4, 2000

Ms. Fay Yee
Office of Research
410 Mrak Hall
University of California
Davis, California, 95616

Dear Ms. Yee:

The San Francisco Estuary Institute (SFEI) is pleased to collaborate with UC Davis on the proposal being submitted to CALFED Bay Delta Program entitled, "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta".

If the proposal is funded, SFEI will accept a subcontract from UC Davis to perform the work outlined in the proposal subject to all established regulations and procedures.

We look forward to the opportunity to work with Dr. Inge Werner on this project.

Sincerely,

Margaret R. Johnston
Executive Director

/mrg

Enclosure

DEPARTMENT OF WATER RESOURCES

ENVIRONMENTAL SERVICES OFFICE
251 S STREET
SACRAMENTO, CA 95816-7017



May 4, 2000

Dr. Inge Werner
University of California
School of Veterinary Medicine
Department of Anatomy, Physiology and
Cell Biology
Davis, California 95616

Dear Dr. Werner:

Thank you for contacting the Department of Water Resources concerning your proposed study on bioaccumulation, trophic transfer and sublethal effects of hydrophobic pesticides and heavy metals in invertebrates and fish in the Sacramento-San Joaquin Delta.

DWR conducts an ongoing program that monitors benthic organism abundance and distribution in the northern portion of the San Francisco Bay and the Sacramento-San Joaquin Delta. Benthic samples are collected monthly from ten sites ranging from San Pablo Bay, east to the Sacramento River (Rio Vista), and the San Joaquin River (Stockton). The objective of this benthic monitoring program is to observe trends in macrobenthic population abundance and distribution throughout the Bay-Delta System and to keep track of species composition (especially newly introduced species).

Your study will contribute considerably to our understanding of the potential ecological effects of anthropogenic pollutants in the Delta. Not much is known about the extent of chemical transfer from the sediment to organisms and across trophic levels, and the effects of these chemical mixtures on invertebrates and fish.

Because this information may be of value in the protection and rehabilitation of invertebrate and certain fish populations, DWR is willing to assist with your field collection and with technical expertise needs during the course of your study. If your project is selected for funding, we are willing to assist you with the collection of clams (*Corbicula fluminea*) and amphipods at the sites we regularly monitor.

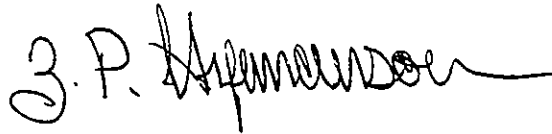
Dr. Inge Werner

May 4, 2000

Page 2

If you have any questions, please contact me at (916) 227-7543, or you may contact Ms. Cindy Messer of my staff at (916) 227-7545.

Sincerely,

A handwritten signature in black ink, appearing to read "Z. P. Hymanson", with a long horizontal flourish extending to the right.

Zach Hymanson, Chief
Monitoring and Analysis Branch



Lawrence Livermore National Laboratory
Center for Accelerator Mass Spectrometry
7000 East Avenue, L-397
Livermore, CA 94551

May 2, 2000

Ingeborg Werner, Ph.D.
Dept. of Anatomy, Physiology and Cell Biology
School of Veterinary Medicine
University of California
Davis CA 95616

Dear Dr. Werner,

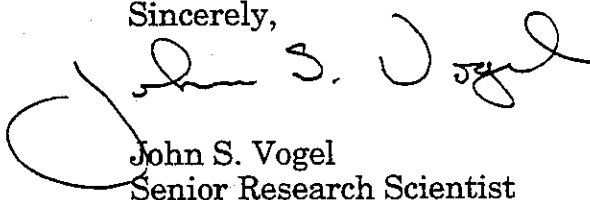
This letter offers collaborative support of your proposal, "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta". The Center for AMS at LLNL has two technologies that can obtain detailed and quantitative analyses of trophic transfer of metals and organic compounds in aquatic systems: accelerator mass spectrometry (AMS) and micro-PIXE.

AMS quantifies ^{14}C -labeled compounds from many matrices at attomole (10^{-18} mol) sensitivity. We will work with your colleague, Guomin Shan, to quantify the uptake of hydrophobic compounds from estuarine muds by clams and amphipods. We would further quantify the trophic transfer of these compounds to the consuming fish. High isotope sensitivity means that low isotope doses can be used in tracing, such as a few nanoCuries ^{14}C total in the initial sediments. AMS is sensitive enough to quantify the target tissues of these compounds in individual animals, for example muscle, CNS, or reproductive tissues. We completed a similar trophic study in which the transfer of labeled food or toxins between individual ants was quantified through several levels in a colony (unpublished). μPIXE provides relative quantitation of heavy elements with 1 micron spatial resolution, should you have need of localizing uptake of toxic elements in specific tissues.

As a DoE laboratory, we must recover all costs of analyses for such collaborative efforts. We hope to have a sample preparation laboratory at UCD in the near future, reducing our costs and your expenses, but a safe number for budgeting processes is \$100 per sample for measurements. If the samples are fully prepared at UCD, this cost will be lower and more samples may be quantified.

Looking forward to working with you,

Sincerely,



John S. Vogel
Senior Research Scientist



California Prune Board

Under Authority of the Secretary of Food and Agriculture, State of California

5990 Stoneridge Drive • Suite 101 • Pleasanton, CA 94588

Tel: (925) 734-0150

Fax: (925) 734-0525

Dr. Inge Werner
VM:APC
University of California
Davis, CA 95616

Dear Dr. Werner:

I would like to take a moment to comment on your proposal, "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta."

As you are well aware, California Agriculture and indeed the Prune Industry are under a lot of pressure to replace several pesticides including the OP Diazinon with reduced risk pesticides. Because of data indicating that Diazinon is entering waterways as a result of dormant applications, Diazinon has been targeted to develop a TMDL and a management program to mitigate this problem. We are already responding to the issue via selection of pesticides that we have been told are good alternatives like pyrethroids. It would be very unfortunate to efforts to correct this problem if the alternative most tree fruit growers are currently going to causes problems as well. Such an outcome could seriously set back these efforts.

As Director of Research for the California Prune Board and a member of the Sacramento River Watershed Project (SRWP)-OP Pesticide Management Stakeholders, I would like to strongly encourage your project go forward as soon as possible. This type of research is critical to making wise decisions in cleaning up California waterways.

Please do not hesitate to get in touch with me if I can provide further information on this very important issue.

Sincerely,

Gary L. Obenauf
Director of Research



Paul E. Helliker
Director

Department of Pesticide Regulation



Gray Davis
Governor

Winston H. Hickox
Secretary, California
Environmental
Protection Agency

May 12, 2000

Dr. Ingeborg Werner
Department of Anatomy, Physiology, and Cell Biology
School of Veterinary Medicine
University of California
Davis, California 95616

Dear Dr. Werner:

Please accept my support of your upcoming project proposal to CALFED—"Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." Since your project will include investigations into the fate, behavior, and toxicity of synthetic pyrethroids in aquatic environments, you will be addressing one of the important data needs related to this class of insecticides. The need for additional data is more acute because use of pyrethroids in the Delta's watershed has been increasing. Our concern is shared by U.S. Environmental Protection Agency's Scientific Advisory Panel, who articulated the need for further study on the effects of pyrethroids on sediment-dwelling organisms and subsequently on aquatic ecosystems.

Good luck on your proposal; I look forward to hearing of the outcome. If you have any questions, please feel free to contact me.

Sincerely,

John S. Sanders, Ph.D.
Branch Chief
Environmental Monitoring and
Pest Management
(916) 324-4100





United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Mail Stop 465
345 Middlefield Road
Menlo Park, CA 94025
snluoma@usgs.gov

May 11, 2000

Dear CALFED:

I am writing to support the application of Dr. Ingeborg Werner et al for funding of the Project: "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." Dr. Werner is an outstanding scientist with whom we have collaborated in the past. The subject she is proposing to study here is of great relevance to our on-going CALFED study of Se impacts and to other USGS studies on contaminants. The interactive effects of multiple contaminant exposures is an aspect of contaminant exposures that we know the least about, but one that is common in nature. We will be very interested in the findings of this study and will collaborate with the PI's wherever possible.

Sincerely,


Samuel N. Luoma

Senior Research Hydrologist

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF ANIMAL SCIENCE
TELEPHONE: (530) 752-1250
FAX: (530) 752-0175

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8521

9 May 2000

Drs. Ingeborg Werner and Swee Joo The
VM: Anatomy, Physiology, and Cell Biology
University of California
One Shields Avenue, Davis

Dear Drs. Ingeborg Werner and S.J. Teh,

This is to confirm my willingness to assist you in obtaining and maintaining white sturgeon for your proposal entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta".

Yours truly,

A handwritten signature in black ink, appearing to read "S. Hung", written over a horizontal line.

Silas S.O. Hung
Professor

Department of Animal Science
University of California
One Shield Ave., Davis
CA 95616-8521



STATEWIDE INTEGRATED PEST
MANAGEMENT PROJECT
TELEPHONE: (530) 752-8350
FAX: (530) 752-6004

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-2621

May 10, 2000

Ingeborg Werner, Ph.D.
University of California
School of Veterinary Medicine
Dept. of Anatomy, Physiology and Cell Biology
1 Shields Ave.,
Davis CA 95616
Fax: (530) 752-7690

Dear Inge:

This letter is to establish my support for your CALFED proposal "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." I have worked with you for the past several years on the issue of pesticide runoff from agricultural and urban issues in my capacity as an entomologist at UC Davis who works on horticultural crops, and I am pleased with the communication we have established between our disciplines. As part of this communication, I have continued to express my feeling that pyrethroid insecticides will be the most likely alternative to organophosphates adopted by growers and urban dwellers. I am concerned that the pyrethroids might present a more lasting environmental problem than do the organophosphates. The research you are proposing helps to address this critical issue.

I hope to continue our interaction in the future, and hope that you will be successful in your pursuit of funding for this proposed research.

Sincerely,

A handwritten signature in black ink, appearing to read "Frank G. Zalom".

Frank G. Zalom
Director and Entomologist



Thomas H. Suchanek
Department of Wildlife, Fish & Conservation Biology
University of California
One Shields Avenue
Davis, California 95616

TEL: (530) 752-9035
FAX: (530) 752-4154
thsuchanek@ucdavis.edu

Dr. Inge Werner
VM:APC
UC Davis
Davis CA 95616

Dear Inge,

I would like to confirm my support of your CALFED proposal "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta".

Your proposed project complements studies we are and have been conducting on the effects of mercury in the Sacramento River watershed. Specifically, we are conducting extensive studies on mercury biouptake and accumulation within the San Francisco Bay-Delta System and identifying sources of upstream mercury from mining sources in the Cache Creek Watershed. It is critical that we expand our knowledge to the effects of metals in conjunction with other contaminants such as pesticides, which are known to be present in the aquatic ecosystem. Specifically, we anticipate that results from your study involving pesticides and heavy metals would nicely complement our ecological data on mercury contamination within both the Cache Creek and Delta ecosystems.

Should your project be funded, we would be anxious to collaborate with you, providing much more leveraged value for your funding than otherwise would be possible.

Best regards,

A handwritten signature in cursive script that reads "Thomas H. Suchanek".

Thomas H. Suchanek
Research Ecologist



COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
(530) 752-0586
FAX: (530) 752-7872

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616

May 10, 2000

Letter of Support

Re: Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta.
P.L.Ingeborg Werner, Ph.D.

From: Thomas Young 
Assistant Professor, Civil & Environmental Engineering, UC Davis

One of my graduate students and I are working on a project that seeks to elucidate the role of specific binding interactions in contaminant sorption to suspended solids and sediments. The interactions are a function of the structure of the contaminant and the organic matter (OM), the typical sorption site on solid particles in surface waters. The contaminants of interest are organophosphate pesticides (OP), chosen for their prevalent and diverse chemical structures.

There are several areas for fruitful collaboration with the team headed by Dr. Werner. First, we are both interested in the same study site, the Sacramento-San Joaquin Delta. Dr. Werner's interest is self evident from her proposal. Our interest is motivated in part by the high concentration of dissolved organic matter (DOM) in the Delta, which makes it possible to collect a few grams of organic matter. This is enough to characterize the OM and perform sorption experiments. We expect to coordinate sampling efforts and share the resulting OM characterization and sorption information.

Second, although our interest in organophosphates is primarily due to their wide range of properties from nonpolar to polar compounds, our initial and most exhaustive experiments will be with a hydrophobic one, chlorpyrifos. Often sorption is treated as partitioning with hydrophobicity as the driving force. Chlorpyrifos provides an opportunity to evaluate the strength of specific interactions and partitioning for the same contaminant. This is a contaminant of interest for both projects because it is widely used in the watershed and is observed in the Delta at concentrations toxic to aquatic invertebrates.

Chemical analysis performed by Dr. Werner's team will tell us the existing levels of contamination prior to sorption experiments we will conduct with suspended solids and sediment. Combining this with water column measurements will facilitate comparison between equilibrium sorption predictions and the *in situ* reality. When combined, our data will provide a measure of contaminant availability from desorption experiments and an understanding of the kinetics, binding strength and types of binding interactions with organic matter. My laboratory is also engaged in a wide range of trace level analysis of metals and organic compounds in soils, sediments, water and biological matrices. Our analytical instruments and method development support will be available to Dr. Werner in the conduct of her study.



DEPARTMENT OF INTEGRATIVE BIOLOGY

BERKELEY, CALIFORNIA 94720-3140

May 5, 2000

CALFED Bay-Delta Program
1416 Ninth St.
Sacramento CA 95814

To Whom it May Concern:

I am providing a letter of collaboration with regards to a CALFED proposal from Dr. Werner of UC Davis entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta". Dr. Werner has asked me to provide this letter as I am the lead investigator on another CALFED-funded pesticide study. UC Berkeley was recently awarded funding for "Assessment of pesticide effects on fish and their food resources in the Sacramento-San Joaquin Delta" (CALFED 99-N08).

Dr. Werner and the other team members have proposed to study toxicity and bioaccumulation of hydrophobic pesticides. As our current CALFED award is less than a month old, scoping is not yet complete so it is difficult to define the precise nature of our collaboration with the proposed work. Given the water column emphasis of our present study, it is my expectation that our focus will be primarily on more water soluble insecticides (e.g., organophosphates and herbicides), and not on the hydrophobic pesticides which Dr. Werner's team is interested in. Work on hydrophobic compounds under the existing contract could, for example include interactions with organophosphate exposures, but is likely to be peripheral to our primary emphasis. Thus, it is my presumption the work will not duplicate our current study.

Dr. Werner is a principal investigator and one of the main players in our current CALFED contract. Thus she will be fully aware of our progress and results, and will have complete access to any data as it may be relevant to her proposed studies.

The endpoints of interest in the proposed study are biomarkers such as lysosomal membrane integrity, stress proteins, and cortisol levels. Many of these same biomarkers are endpoints that Dr. Werner will be measuring in our present study in exposures of salmon to other pesticides, most likely organophosphates. Coupled with her research in the proposed study, these efforts will provide information on biomarker response to a broad array of pesticides in use in California.

If you have any questions, feel free to call me at 510-231-5626.

Sincerely,

Donald P. Weston



UC SYSTEMWIDE GRADUATE PROGRAM IN ECOTOXICOLOGY
An Environmental and Ecological Instruction and Training Program
TEL: 916/752-1029
FAX: 916/752-9692

DAVIS, CALIFORNIA 95616-8732

May 10, 2000

Ingeborg Werner, Ph.D.
University of California
School of Veterinary Medicine
Dept. of Anatomy, Physiology and Cell Biology
1 Shields Ave., Davis CA 95616

Dear Inge:

I am writing to express my interest and willingness to collaborate with your proposed study on the potential effects of hydrophobic pesticides and heavy metals on fishes in the San Francisco estuary.

As you know, similar studies on the potential effects of contaminants on fish populations has been a re-occurring research focus in my research group. Currently, we are examining such questions with regard to delta smelt and pesticides on a grant funded by CALFED. No doubt there will be several areas in which our individual projects can benefit from a cooperative effort.

Best of luck with the proposal.

Sincerely,

A handwritten signature in cursive script, appearing to read "Bill", is written in dark ink.

William A. Bennett
Assistant Research Scientist
John Muir Institute of the Environment &
Bodega Marine Laboratory
University of California, Davis
POB 247
Bodega Bay, CA 94923
707-875-2035

Environmental Compliance Checklist

All applicants must fill out this Environmental Compliance Checklist. Applications must contain answers to the following questions to be responsive and to be considered for funding. Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.

1. Do any of the actions included in the proposal require compliance with either the California Environmental Quality Act (CEQA), the National Environmental Policy Act (NEPA), or both?

YES

X

NO

2. If you answered yes to # 1, identify the lead governmental agency for CEQA/NEPA compliance.

Lead Agency

3. If you answered no to # 1, explain why CEQA/NEPA compliance is not required for the actions in the proposal.

We will perform all sampling with the Department of Water Resources and their DWR Compliance Monitoring Program in the Sacramento-San Joaquin Delta. -
All other work will be done in the laboratory on campus of the University of California at Davis, and in the laboratories of the San Francisco Estuary Institute, Richmond, CA.

4. If CEQA/NEPA compliance is required, describe how the project will comply with either or both of these laws. Describe where the project is in the compliance process and the expected date of completion.

5. Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?

YES

X

NO

If yes, the applicant must attach written permission for access from the relevant property owner(s). Failure to include written permission for access may result in disqualification of the proposal during the review process. Research and monitoring field projects for which specific field locations have not been identified will be required to provide access needs and permission for access with 30 days of notification of approval.

6. Please indicate what permits or other approvals may be required for the activities contained in your proposal. Check all boxes that apply.

LOCAL

Conditional use permit	_____
Variance	_____
Subdivision Map Act approval	_____
Grading permit	_____
General plan amendment	_____
Specific plan approval	_____
Rezone	_____
Williamson Act Contract	_____
cancellation	_____
Other _____	
(please specify)	
None required	<u> X </u>

STATE

CESA Compliance	_____	(CDFG)
Streambed alteration permit	_____	(CDFG)
CWA § 401 certification	_____	(RWQCB)
Coastal development permit	_____	(Coastal Commission/BCDC)
Reclamation Board approval	_____	
Notification	_____	(DPC, BCDC)
Other _____		
(please specify)		
None required	<u> X </u>	

FEDERAL

ESA Consultation	_____	(USFWS)
Rivers & Harbors Act permit	_____	(ACOE)
CWA § 404 permit	_____	(ACOE)
Other _____		
(please specify)		
None required	<u> X </u>	

DPC = Delta Protection Commission

CWA = Clean Water Act

CESA = California Endangered Species Act

USFWS = U.S. Fish and Wildlife Service

ACOE = U.S. Army Corps of Engineers

ESA = Endangered Species Act

CDFG = California Department of Fish and Game

RWQCB = Regional Water Quality Control Board

BCDC = Bay Conservation and Development Comm.

Land Use Checklist

All applicants must fill out this Land Use Checklist for their proposal. Applications must contain answers to the following questions to be responsive and to be considered for funding. Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.

1. Do the actions in the proposal involve physical changes to the land (i.e. grading, planting vegetation, or breaching levees) or restrictions in land use (i.e. conservation easement or placement of land in a wildlife refuge)?

YES

 X
NO

2. If NO to # 1, explain what type of actions are involved in the proposal (i.e., research only, planning only).

research only

3. If YES to # 1, what is the proposed land use change or restriction under the proposal?

4. If YES to # 1, is the land currently under a Williamson Act contract?

YES

NO

5. If YES to # 1, answer the following:

Current land use

Current zoning

Current general plan designation

6. If YES to #1, is the land classified as Prime Farmland, Farmland of Statewide Importance or Unique Farmland on the Department of Conservation Important Farmland Maps?

YES

NO

DON'T KNOW

7. If YES to # 1, how many acres of land will be subject to physical change or land use restrictions under the proposal?

8. If YES to # 1, is the property currently being commercially farmed or grazed?

YES

NO

9. If YES to #8, what are

the number of employees/acre _____

the total number of employees _____

10. Will the applicant acquire any interest in land under the proposal (fee title or a conservation easement)?

YES

X
NO

11. What entity/organization will hold the interest?_____

12. If YES to # 10, answer the following:

Total number of acres to be acquired under proposal

Number of acres to be acquired in fee

Number of acres to be subject to conservation easement

13. For all proposals involving physical changes to the land or restriction in land use, describe what entity or organization will:

manage the property

provide operations and maintenance services

conduct monitoring

14. For land acquisitions (fee title or easements), will existing water rights also be acquired?

YES

NO

15. Does the applicant propose any modifications to the water right or change in the delivery of the water?

YES

NO

16. If YES to # 15, describe _____

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SCHOOL OF VETERINARY MEDICINE
DEPARTMENT OF ANATOMY, PHYSIOLOGY & CELL BIOLOGY
(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Bay Conservation and Development Commission
30 Van Ness Ave, R. 2011
San Francisco CA 94102

To whom it May Concern,

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta."

The proposed project is a collaborative effort among investigators at the University of California and San Francisco Estuary Institute, with sampling assistance provided by the California Department of Water Resources. We propose to study the effects of sediment-associated pesticides and heavy metals on resident invertebrate species, and the potential for uptake of these contaminants by juvenile salmon and white sturgeon via their food sources. In addition, toxic effects of these contaminants on the two fish species will be investigated in the laboratory. Benthic invertebrate samples will be collected for a two year period at 4 sites in the Sacramento-San Joaquin Delta, as part of the Department of Water Resource's regularly scheduled monthly monitoring program.

CALFED will make the funding decisions later this year, and if our study is funded, work will be performed from fall 2000 through fall 2002. If you have any questions please call me at 530-754-8060.

Sincerely,

Ingeborg Werner
Assistant Research Scientist

UNIVERSITY OF CALIFORNIA, DAVIS

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(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Delta Protection Commission
14215 River Toad
PO Box 530
Walnut Grove CA 95690

To whom it May Concern,

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta."

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Sincerely,

Ingeborg Werner
Assistant Research Scientist

UNIVERSITY OF CALIFORNIA, DAVIS

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(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Solano County Board of Supervisors
580 Texas Street
Fairfield CA 94533

To whom it may concern:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

The proposed project is a collaborative effort among investigators at the University of California and San Francisco Estuary Institute, with sampling assistance provided by the California Department of Water Resources. We propose to study the effects of sediment-associated pesticides and heavy metals on resident invertebrate species, and the potential for uptake of these contaminants by juvenile salmon and white sturgeon via their food sources. In addition, toxic effects of these contaminants on the two fish species will be investigated in the laboratory. Benthic invertebrate samples will be collected for a two year period at 4 sites in the Sacramento-San Joaquin Delta, as part of the Department of Water Resource's regularly scheduled monthly monitoring program.

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Sincerely,

Ingeborg Werner
Assistant Research Scientist

UNIVERSITY OF CALIFORNIA, DAVIS

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SANTA BARBARA • SANTA CRUZ

SCHOOL OF VETERINARY MEDICINE
DEPARTMENT OF ANATOMY, PHYSIOLOGY & CELL BIOLOGY
(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Solano County Planning Commission
601 Texas Street
Fairfield CA 94533

To whom it may concern:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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Sincerely,

Ingeborg Werner
Assistant Research Scientist

UNIVERSITY OF CALIFORNIA, DAVIS

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(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Mr. Ben Hulst
Community Development Department
Planning Division
1810 E. Hazelton
Stockton CA 95205

Dear Mr. Hulst:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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Sincerely,

Ingeborg Werner
Assistant Research Scientist

UNIVERSITY OF CALIFORNIA, DAVIS

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DEPARTMENT OF ANATOMY, PHYSIOLOGY & CELL BIOLOGY
(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Ms Lois Sahyoun
Clerk of the Board
County Board of Supervisors
Courthouse, Room 701
222 East Weber Ave
Stockton CA 95202

Dear Ms. Sahyoun:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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CALFED will make the funding decisions later this year, and if our study is funded, work will be performed from fall 2000 through fall 2002. If you have any questions please call me at 530-754-8060.

Sincerely,

Ingeborg Werner
Assistant Research Scientist

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

SCHOOL OF VETERINARY MEDICINE
DEPARTMENT OF ANATOMY, PHYSIOLOGY & CELL BIOLOGY
(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Thomas W. Hutchings
Planning and Community Development
827 7th Street, Room 230
Sacramento CA 95814

Dear Mr. Hutchings:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Contra Costa Community Development Department
attn Dennis M. Marry, Director
651 Pine Street
Martinez CA 94553
Cindy H. Turner

Dear Dr. Marry:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Office of the County Board of Supervisors
attn: D. Gerber (Chair)
615 Pine Street
Martinez CA 94553

Dear Dr. Gerber:

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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Sincerely,

Ingeborg Werner
Assistant Research Scientist



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(530) 752-1174
FAX: (530) 752-7690

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8732

May 12, 2000

Cindy H. Turner
Clerk of the Board
County Board of Supervisors
700 H Street, Suite 2450
Sacramento CA 95814

Dear Ms. Turner,

This letter is to notify you that the University of California, Davis, is submitting a proposal to CALFED entitled "Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta." CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

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Sincerely,

Ingeborg Werner
Assistant Research Scientist

NONDISCRIMINATION COMPLIANCE STATEMENT

STD. 19 (REV. 3-95)

COMPANY NAME **THE REGENTS OF THE UNIVERSITY OF CALIFORNIA**
University of California, Davis Campus

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, physical disability (including HIV and AIDS), medical condition (cancer), age (over 40), marital status, denial of family care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

Fay Yee

DATE EXECUTED

MAY 12 2000

EXECUTED IN THE COUNTY OF
YOLO

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE

Contracts and Grants Analyst

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA
University of California, Davis Campus

**APPLICATION FOR
FEDERAL ASSISTANCE**

1. TYPE OF SUBMISSION: <i>Application</i> <input type="checkbox"/> Construction <input checked="" type="checkbox"/> Non-Construction <i>Preapplication</i> <input type="checkbox"/> Construction <input type="checkbox"/> Non-Construction	2. DATE SUBMITTED 5-15-2000	Application Identifier
	3. DATE RECEIVED BY STATE	State Application Identifier
	4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

5. APPLICATION INFORMATION

Legal Name The Regents of the University of California	Organizational Unit University of California, Davis, VM:APC
Address (give city, county, state, and zip code) Office of the Vice Chancellor for Research University of California, Davis 410 Mrak Hall Davis, CA 95616 YOLO COUNTY	Name and telephone number of the person to be contacted on matters involving this application (give area code) Administrative Contact Technical Contact Fay Yee - 530-752-2075 Ingeborg Werner, Ph.D. ffyee@ucdavis.edu (530)754-8060, iwerner@ucdavis.edu

6. EMPLOYER IDENTIFICATION NUMBER (EIN):

9	4	—	6	0	3	6	4	9	4
---	---	---	---	---	---	---	---	---	---

8. TYPE OF APPLICATION:
☐ New ☐ Continuation ☐ Revision
If Revision, enter appropriate letter(s) in boxes(es) ☐ ☐
A. Increase Award B. Decrease Award C. Increase Duration
D. Decrease Duration Other (specify):
7. TYPE OF APPLICANT: (enter appropriate letter in box) ☒ I

A. State	H. Independent School Dist.
B. County	I. State Controlled Institution of Higher Learning
C. Municipal	J. Private University
D. Township	K. Indian Tribe
E. Interstate	L. Individual
F. Intermunicipal	M. Profit Organization
G. Special District	N. Other (Specify):

9. NAME OF FEDERAL AGENCY: CALFED**10. CATALOG OF FEDERAL DOMESTIC
ASSISTANCE NUMBER:**

--	--	--	--	--	--

TITLE:

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:

Bioaccumulation, Trophic Transfer and Sublethal Effects of Hydrophobic Pesticides and Heavy Metals in Invertebrates and Fish in the Sacramento-San Joaquin Delta

**12. AREAS AFFECTED BY PROJECT (cities, counties, states, etc.)
Contra Costa, Solano, Sacramento and San Joaquin
Counties, California****13. PROPOSED PROJECT:**

Start Date 10-1-2000	Ending Date 9-30-2003
-------------------------	--------------------------

14. CONGRESSIONAL DISTRICTS OF:

a. Applicant 3	b. Project 1, 3, 5, 7, 10, 11
-------------------	----------------------------------

15. ESTIMATED FUNDING:

a. Federal	\$ 1,103,473
b. Applicant	\$
c. State	\$
d. Local	\$
e. Other	\$
f. Program Income	\$
g. TOTAL	\$ 1,103,473

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

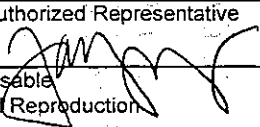
a. YES. THIS PRE-APPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE _____

b. NO. X PROGRAM IS NOT COVERED BY E.O. 12372

☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW**17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?**☐ Yes If "Yes," attach an explanation. ☒ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREA-PPLICATION ARE TRUE AND CORRECT, THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Typed Name of Authorized Representative Fay Yee	b. Title Contracts and Grants Analyst	c. Telephone number (530) 752-2075
d. Signature of Authorized Representative 		e. Date Signed MAY 12 2000

BUDGET INFORMATION - Non-Construction Programs

SECTION A - BUDGET SUMMARY						
Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Ecosystem Restoration Program		\$	\$	\$ 1,140,834	\$	\$ 1,140,834
2.						
3.						
4.						
5. Totals		\$	\$	\$ 1,140,834	\$	\$ 1,140,834
SECTION B - BUDGET CATEGORIES						
Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY			Total (5)		
	(1) Total Project (2)	(3)	(4)			
a. Personnel	\$ 451,317	\$	\$	\$ 451,317		
b. Fringe Benefits	88,230			88,230		
c. Travel	9,000			9,000		
d. Equipment	7,500			7,500		
e. Supplies (*incl. analyt. chem.)	161,550*			161,550*		
f. Contractual	67,307			67,307		
g. Construction	0			0		
h. Other	4,840			4,840		
i. Total Direct Charges (sum of 6a-6h)	789,744			789,744		
j. Indirect Charges	351,090			351,090		
k. TOTALS (sum of 6i and 6j)	\$ 1,140,834	\$	\$	\$ 1,140,834		
7. Program Income	\$	\$	\$	\$		

SECTION C - NON-FEDERAL RESOURCES					
(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS	
8.	\$	\$	\$	\$	
9.					
10.					
11.					
12. TOTAL (sum of lines 8-11)	\$ 0.00	\$	\$	\$ 0.00	
SECTION D - FORECASTED CASH NEEDS					
	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	\$ 298,970	\$ 81,477	\$ 72,807	\$ 70,871	\$ 73,815
14. Non-Federal					
15. TOTAL (sum of lines 13 and 14)	\$ 298,970	\$ 81,477	\$ 72,807	\$ 70,871	\$ 73,815
SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT					
(a) Grant Program	FUTURE FUNDING PERIODS (Years)				
	(b) First	(c) Second	(d) Third	(e) Fourth	
16. Ecosystem Restoration Program	\$ 298,970	\$ 496,887	\$ 344,977	\$	
17.					
18.					
19.					
20. TOTAL (sum of lines 16-19)	\$ 298,970	\$ 496,887	\$ 344,977	\$	
SECTION F - OTHER BUDGET INFORMATION					
21. Direct Charges:	\$789,744	22. Indirect Charges: \$351,090			
23. Remarks: Indirect costs are calculated at a rate of 46.5 (year 1), 48 (year 2), and 48.5 (year 3) percent of modified direct costs (i.e. less equipment, student fees and subcontract amounts over initial \$25,000).					

ASSURANCES - NON-CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

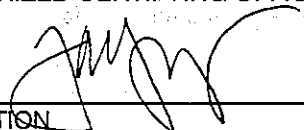
NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.
2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.
3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.
4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.
5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).
6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.
7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.
8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.
10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is \$10,000 or more.
11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).
12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.
13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).
14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.
15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.
16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.
17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."
18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL



TITLE

Fay Yee
Contract & Grant Analyst

APPLICANT ORGANIZATION

THE REGENTS OF THE UNIVERSITY
OF CALIFORNIA

DATE SUBMITTED

MAY 12 2000

U.S. Department of the Interior

**Certifications Regarding Debarment, Suspension and
Other Responsibility Matters, Drug-Free Workplace
Requirements and Lobbying**

Persons signing this form should refer to the regulations referenced below for complete instructions:

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions - The prospective primary participant further agrees by submitting this proposal that it will include the clause titled, "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions. See below for language to be used; use this form for certification and sign; or use Department of the Interior Form 1954 (DI-1954). (See Appendix A of Subpart D of 43 CFR Part 12.)

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions - (See Appendix B of Subpart D of 43 CFR Part 12.)

Certification Regarding Drug-Free Workplace Requirements - Alternate I. (Grantees Other Than Individuals) and Alternate II. (Grantees Who are Individuals) - (See Appendix C of Subpart D of 43 CFR Part 12.)

Signature on this form provides for compliance with certification requirements under 43 CFR Parts 12 and 18. The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of the Interior determines to award the covered transaction, grant, cooperative agreement or loan.

**PART A: Certification Regarding Debarment, Suspension, and Other Responsibility Matters -
Primary Covered Transactions**

CHECK ☒ IF THIS CERTIFICATION IS FOR A PRIMARY COVERED TRANSACTION AND IS APPLICABLE.

- (1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
 - (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
 - (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
 - (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
 - (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.
- (2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

**PART B: Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion -
Lower Tier Covered Transactions**

CHECK ☐ IF THIS CERTIFICATION IS FOR A LOWER TIER COVERED TRANSACTION AND IS APPLICABLE.

- (1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
- (2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

DI-2010
March 1995
(This form consolidates DI-1953, DI-1954,
DI-1955, DI-1956 and DI-1963)

PART C: Certification Regarding Drug-Free Workplace Requirements

CHECK ☒ IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS NOT AN INDIVIDUAL

Alternate I. (Grantees Other Than Individuals)

A. The grantee certifies that it will or continue to provide a drug-free workplace by:

- (a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
- (b) Establishing an ongoing drug-free awareness program to inform employees about--
 - (1) The dangers of drug abuse in the workplace;
 - (2) The grantee's policy of maintaining a drug-free workplace;
 - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
 - (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
- (c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
- (d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --
 - (1) Abide by the terms of the statement; and
 - (2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
- (e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;
- (f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted --
 - (1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
 - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
- (g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

Check ☐ if there are workplaces on file that are not identified here.

PART D: Certification Regarding Drug-Free Workplace Requirements

CHECK ☐ IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS AN INDIVIDUAL

Alternate II. (Grantees Who Are Individuals)

- (a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;
- (b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant.

PART E: Certification Regarding Lobbying
Certification for Contracts, Grants, Loans, and Cooperative Agreements

CHECK ☒ IF CERTIFICATION IS FOR THE AWARD OF ANY OF THE FOLLOWING AND THE AMOUNT EXCEEDS \$100,000: A FEDERAL GRANT OR COOPERATIVE AGREEMENT, SUBCONTRACT, OR SUBGRANT UNDER THE GRANT OR COOPERATIVE AGREEMENT.

CHECK ☐ IF CERTIFICATION IS FOR THE AWARD OF A FEDERAL LOAN EXCEEDING THE AMOUNT OF \$150,000, OR A SUBGRANT OR SUBCONTRACT EXCEEDING \$100,000, UNDER THE LOAN.

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

As the authorized certifying official, I hereby certify that the above specified certifications are true.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL

Fay Yee

TYPED NAME AND TITLE Contract & Grant Analyst

DATE

MAY 12 2000

DI-2010

March 1995

(This form consolidates DI-1953, DI-1954,

DI-1955, DI-1956 and DI-1963)



Office of the Vice Chancellor for Research
410 Mrak Hall, One Shields Avenue
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E-Mail: ffyee@ucdavis.edu
ccgarcia@ucdavis.edu

11 May 2000

CALFED Bay-Delta Program Office

1416 Ninth Street, Suite 1155
Sacramento, California 95814

Dear Colleague:

Proposal in Support of Project Entitled
"Bioaccumulation, trophic transfer and sublethal effects of hydrophobic pesticides &
heavy metals in invertebrates & fish in the Sacramento-San Joaquin Delta"
Principal Investigator - **Inge Werner**

It is a pleasure to present for your consideration the referenced proposal in response to your 2001 Proposal Solicitation for the Ecosystem Restoration Projects and Programs.

Following the direction of "Attachment D - Terms and Conditions for State Proposition 204 Funds," this is to provide notification that University of California takes exception to the following proposed "standard" clauses:

Section 6 - Substitution
Section 9 - Rights in Data
Section 11 - Indemnification, and
Standard Clauses - Insurance Requirements - DWR

In order to bring the above provisions into conformity with the University of California policy, we reserve the right to discuss with the aim of properly modifying these sections, should this proposal result in a subsequent award.

Please contact the principal investigator for scientific information. Administrative questions may be directed to me or to my assistant, Mr. Carlos Garcia, by telephone, facsimile, or electronic mail at the numbers cited above. Furthermore, correspondence pertaining to this proposal and any subsequent award should be sent to the Office of the Vice Chancellor for Research and to the principal investigator.

Sincerely,

A handwritten signature in black ink, appearing to read 'Fay Yee', written over a circular stamp.

Fay Yee
Contracts and Grants Analyst

Enclosures

c: D.M. Hyde
I. Werner